SECTION - 5.1: 1.1KV GRADE POWER AND CONTROL CABLES

Clause No.	Particulars
1.0	REQUIREMENTS FOR 1.1kV GRADE CABLES
2.0	TECHNICAL
2.1	CODES AND STANDARDS
2.2	TECHNICAL REQUIRMENTS
2.3	L.T. PVC POWER CABLES
2.4	L.T. PVC CONTROL CABLES
2.5	VOID
2.6	CABLE DRUMS
2.7	TESTS

1. REQUIREMENTS FOR 1.1 kV GRADE CABLES:

1.0 Qualifying Requirement:

Please refer Volume - 1 Section IFB Clause 11.0

1.1 **GENERAL:**

The bidder shall quote for cables for entire scope of work. Following are the preferred sizes of cables to be used in the project and the cable vis a vis the purpose f or which to be used in indicated in part 1 of 3 of volume - II i.e., technical specifications.

PVC POWER CABLES (ALUMINUM CABLES):- NOT APPLICABLE

4C x 95mm²
4C x 25 mm²
2C x 10mm²
2C x 70mm²

PVC CONTROL CABLES (STANDARD COPPER CABLES):

2C x 2.5 mm²
10C x 2.5 mm²
19C x 2.5 mm²
4C x 6 mm²
4C x 10 mm²
4C x 25 mm²

1.2 Successful bidder shall prepare entire laying and termination schedules in accordance with criteria stipulated at Clause 1.3 below along with final cable quantities required and the same shall be submitted in advance for Owner's approval.

1.3 **CRITERIA FOR SELECTION OF POWER & CONTROL CABLES:**

1.3.1 Aluminum conductor P V C insulated armoured power cables shall be used for main power supply purpose from LT Aux. Transformers to control room.

1.3-2 Aluminum conductor P V C insulated armoured power cables shall be used for various other applications in switchyard area / control room except for control / protection purposes.

1.3.3 For all control / protection instrumentation purposes PVC insulated armoured control cables of minimum 2.5 sq. mm. size with stranded copper conductors shall be used.

1.3.4 The size of the Power&Control and power cables for various purposeshave been indicated in part 1 of 3 of technical specifications.

The bidder has to assess the quantities and indicate in the bid proposal sheets. In some cases, tentative quantities have been indicated. These can be reassessed and indicated by bidder.

The Bidder may offer other than sizes specified, in such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop and short circuit consideration of system. Relevant calculation shall be submitted by the bidder during detailed engineering for Purchaser approval.

The successful bidder has to finalize the cable schedules based on the site conditions and the schemes quoted, which are to be approved by owner payment for control and power cables will be made quantities of both power and control cables indicated in the bid proposal sheets and quantities finalized as per cable schedules WHICHEVER is LOWER

1.3.5 While preparing cables schedules for control / protectionpurposes following shall be ensured:

Separate cables shall be used for AC & DC

For different cores of CT, CVT, & VTs separate cables shall be used.

At least one (1) core shall be kept as spare in each copper control cables up to 9C size whereas minimum no of spare cores shall be two (2) for control cables of 10 cores or higher size.

For control cabling, 2.5 sq. mm copper cables shall be used for connections. For CT & VT circuits 6 &10 sq. mm copper control cables shall be used, respectively.

2.0 TECHNICAL:

2.1.0 CODES & STANDARDS

The design manufacture testing and performance of cables covered under this specification shall comply with latest edition of the following standards including amendments:

IS:7098 XLPE insulated PVC sheathed cables
(Part-I) for working voltage up to & including 1100 Volts

ISS130 Conductors for insulated electrical cables & flexible cords.

IS:5831 PVC insulation & sheath of electrical cables.

IS:3975 Mild steel wires strips & tapes for arm armoring of cables.

IS:10418 Specification of drums for electric cables

IS: 1554 PVC insulated (heavy duty) electric cables for working voltage (part-I) up to and including 1100 V.

ASTMD Measuring & minimum oxygen concentration to support 2683 candle like combustion of plastic(oxygen index).

2.1.2 Cables complying with other internationally accepted standards such as IEC, VDE, JPCEA etc.,will alsobe consideredif they ensure performance& constructional features equivalent or superior to standards listed above. In such a case, theBidder shall clearly indicate the standard / standards adopted and furnish a copy of English version of the latest revision of the standard(s) along with the tender & shall clearly bring out the salient features for comparison.

2.1.3 In case of any conflict between the referred specifications codes or standards &this technical specification, the latter shall prevail to the extent of such difference.

2.1.4 1.1 kV grade power &control cables to be supplied under this package shall be ISI approved & marked as such. Non-compliance of above shall not be accepted.

2.1.5 However, if cables to be, supplied under this package are manufactured outside India confirm to other internationally accepted equivalent or superior standards the above specification is notapplicable.

2.1.6 The Indian Standards mentioned in Clause 2.1 can be Obtained from: - Bureau of Indian Standards
Manak Bhavan,
9. Bahadur Shah Zafar Marg,
NewDelhi - 110002.
INDIA.

2.2.0 **TECHNICAL REQUIREMENTS:**

2.2.1 **GENERAL**

2.2.1.1 The cables shall be suitable for laying in racks, ducts, trenches, conduits & underground buried installation with uncontrolled back fill & chance of flooding by water.

2.2.1.2 They shall be designed to withstand all mechanical, electrical &thermal stress under steady & transient operating conditions.

2.2.1.3 The Aluminum / Copper wires used for manufacturing the cables shall be true circular in shape before stranding should be uniformly of good quality, free from defects. All aluminum used in the cable shall be of H2 grade.

2.2.1.4 The fillers & inner sheath shall be of non-hygroscopic & shall be softer than insulation The outer sheath must be fill reluctant suitable for the operating temperature of the cable.

2.2.1.5 Progressive sequential marketing of the length of the cable in meters. Every one meter shall be provided on the outer sheath of all cables.

2.2.1.6 Only galvanized round steel wire armour shall be used for multicore cables. G.S.striparmour shall not be accepted for these cables.

2.2.1.7 The cables shall have outer sheath of a material with an oxygen index of not less than 29 & a temperature index of not less than 250º C.

2.2.1.8 All the cables shall pass fire resistance test as per IS:1554(part-1).

2.2.1.9 The PVC cables insulated cables shall be capable of withstandin a conductor temperature of 160º C during a short circuit.

2.2-1-10 Repaired cables shall not be accepted.

2.2-1-11 Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

2.2-1-12 The normal current rating of PVC insulated cables shall be as per IS 3961.

2.3 L.T. PVC Power Cables.

The P V C (70ºC) insulated 100V grade power cables shall beof FRtype clause category, conforming to IS:1554 (Part-I) its amendments, read along with this specification & shall be suitable for steady conductor temperature 70 º C. The conductor shall be stranded Aluminum. The insulation shall be extruded P V C to type-A of IS: 5831. A distinct inner sheath shall be provided in all multi-core cables. For multicore armored cables, the inner sheath shall be of extruded P V C. The, outer sheath shall be extruded PVC to type ST-1 of IS: 5831 for all cables . Where armoring is specified for single core cables the same shall be of aluminum wires /strips.

2.4 L.T. PVC Control Cables:

2-4. 1 The 1100 grade 70° C control cables shall be of FR type Clause category confirming to IS: 1554 (Part-I) & its amendments, read along with this specification Theconductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS:5831. A distinct extruded inner sheath shall be provided in all cables. The fire retardant over sheath shall be extruded P V C to type ST-1 of IS: 5831 & shall be grey in color except where specifically advised by the owner to be black.

2.4.2 Cores shall be identified as per IS:554 for the cables up to five (5) cores & for cables with more than five (5) cores the identification of cores shall done by printing legible Hindu Arabic Numerals on all cores as per clause 10.3 of IS :1554(Part-1).

2.50 VOID

2.6.0 **CABLE DRUMS**

2.6.1 Cables shall be supplied non-returnable wooden, or steel drums of heavy construction & drum shall be properly seasoned sound & free from defects. Wood preservative shall be applied to the entire drum.

2.6.2 Standard lengths for each size on power & control cables to be supplied by bidder shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard length. The owner shall have the option of rejecting cable drums with Shorter lengths. However, the total quantity of cables after taking into consideration of all cable drum of each size shall be within tolerance of 2%.

2.6.3 A layer of waterproof paper shall be applied to the surface of the drums over the outer most cable layer.

2.6.4 A clear space of atleast 40 mm shall be left between the cables & the lagging.

2.6.5 Each drum shall carry the manufacture's name, the owner's name, address, contract number & type, size & length of the cable, net & gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable an arrow & suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

2.6.6 Packing shall be sturdy & adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling & storage. Both cables ends shall be scaled with good quality heat shrinkable caps so as to eliminate ingress of water during transportation & erection.

2.7.0 **TYPE TESTS**

2.7.1 All cables shall conform to all type routine & acceptance tests listed in the relevant-IS.

2.7.2 The type tests on cables shall be conducted on each type and size of cables offered.

2.7.3 Following type tests as per IS:1554(Part-I)-1988 including its amendments and additional type tests shall be carried out on 1.1KV grade PVC insulated cables:

a. Tests on conductor
   i. Annealing test (for copper)
   ii. Tensile test (for aluminum)
   iii. Wrapping test (for aluminum)
   iv. Conductor Resistance test.
b. Test for armouring wires/strips
c. Test for thickness of insulation and sheath
d. Physical tests for insulation and outer sheath.
   i. Tensile strength and elongation at break
   ii. Ageing in air oven
   iii. Shrinkage test
   iv. Hot deformation, Loss of mass
   v. Heat shock test
   vi. Thermal stability.
e. Insulation resistance
f. High voltage test (water immersion test only a.c. test as per clause No. 16.3.1)
g. High voltage test at room temperature
h. Flammability test
i. Oxygen index and temperature index test on outer sheath
j. Short time current test on power cables of sizes 240 Sq. mm and above.
   i. On conductor(s)
   ii. On armours.

2.7.4 Following type tests as per IS:7098(Part-2)-1988 including its amendments and additional type tests shall be carried out on XLPE insulated HT cable up to 33KV earthed system:

i. Tests on conductor
   a. Annealing test (for Copper)
   b. Tensile test (for aluminium)
   c. Wrapping test (for aluminium)
   d. Resistance test.
ii. Test for armouring wires/strips
iii. Test for thickness of insulation
iv. Physical tests for insulation
v. Physical tests for outer sheath
vi. Partial discharge test

vii. Bending test
viii. Dielectric power factor test
ix. Heating cycle test
x. Impulse withstand test
xi. High voltage test
xii. Oxygen index temperature index test on outer sheath

2.7.5 Following type tests as per IS:7098 (part-3)-1993 including its amendments and additional type tests and additional type tests shall be carried out on XLPE insulated HT cable.

a. Tests on conductor
   i. Annealing test(for copper)
   ii. Resistance test
   iii. Tensile test (for aluminim)
   iv. Wrapping test (for aluminium)
b. Physical tests for insulation
   i. Test for thickness and dimensions of insulation
   ii. Tensile strength and elongation at break
   iii. Hot set test
   iv. Shrinkage test
   v. Thermal ageing in air oven
c. Resistivity test for semi-conducting layers
d. Test for concentric metallic screen:
   i. Test for concentric copper wire
   ii. Test for concentric copper tape
e. Thickness of metallic sheath
f. Test for armouring material:
   i. Dimensions.
g. Physical tests for outer sheath:
   1. Measurement of thickness
   2. PVC sheath
      i. Tensile strength and elongation at break
      ii. Ageing in air oven
      iii. Loss of mass in air oven only for PVC sheath
      iv. Heat shock test
      v. Hot deformation test
      vi. Shrinkage test
      vii. Thermal stability

   3. PE sheath.

      2. Carbon black content
      3. Tensile strength and elongation at break before and after ageing.
      4. Hot-deformation.
h. Flammability test (for PVC outer sheathed cables only)
i. Water tightness test
      1. Thermal ageing on complete cable sample.
      2. Tensile strength and elongation at break for insulation and outer sheath.

3. Resistivity test for semi-conducting layer

j. Bending test followed by P.D. test
k. Dielectric power factor and capacitance measurement at ambient temperature
l. Dielectric power factor measurement at elevated temperature
m. Impulse withstand test followed by HV test.
n. Oxygen index temperature index test on outer sheath.

2.7.6 Contractor shall submit type test reports as per clause No. 9.2 of Technical Specification, Section: GTR for which test conducted once are acceptance (i.e. The requirement of test conducted within last five years shall not be applicable) for the following:

2.7.7 1.1kV grade PVC insulated cables

High voltage test (water immersion d.c. test as per clause No. 16.3.2 of IS: 1554 (Part-1)-1988)

2.7.8 1.1KV grade XLPE insulated cables

a. Water absorption (gravimetric) test as per IS: 7098 (part-1)-1988

2.7.9 XLPE insulated HT cable from 66KV upto and including 220KV

a. Load cycle test followed by P.D. measurement as per IS:7098 (part-3)

2.7.10 Terminating/jointing accessories as per IEC 60840:1999

a. Partial discharge test at ambient temperature;
b. Heating cycle voltage test
c. Partial discharge tests
-At ambient temperature
-At high temperature
d. Impulse voltage test followed by power frequency test.
e. Test of outer protection for buried joints.

2.7.11 The owner reserves the right to witness any or all the tests, for which at least 30 days advance notice, shall be given-by the contractor.

2.7.11.1 Ten(10) copies of all routine & type test results shall be submitted for approval before dispatch of the cables from the works.

2.7.12 Bound copies of complete test reports, ten (10) in number, shall be furnished along with the cables. These shall include complete reports & results of the type tests, acceptance tests routine tests.

2.7.13 The owner reserves the light to get the cable Type tests at his own expense for any further tests to verify the compliance with the specifications & to reject the cables in case they are found not satisfying the qualifying requirements as per relevant standards.

SECTION –5.2 :6.6 kV UG CABLE

Clause No.	Particulars
1.0	**Qualifying requirement for 6.6 kV UG Cable**
2.0	General
3.0	Technical
4.0	Cable Ducts
5.0	Tests
6.0	Cable Laying
	Technical Specification for joints and terminations suitable for 6.6kV class XLPE Insulated UG cable
1.0	Qualifying Requirement for Manufacturers
2.0	Service conditions
3.0	Power system particulars
4.0	Standards
5.0	Design Requirements
6.0	Tests

TECHNICAL SPECIFICATIONS FOR 6.6 kV UG CABLE

1.0 QUALIFYING REQUIRMENT FOR MANUFACTURER:
Please refer volume – 1, Section –I-IFB.

2.0 GENERAL:
The bidder shall quote for the entire scope of work. The preferred cable size is 3 core, 95 sq. mm, 240 sq. mm, 400 Sq. mm & 1 core 1000 sq. mm

2.1 Successful bidder shall prepare the entire laying, jointing and termination schedule.

3.0 TECHNICAL:

3.1 Standard: The underground cable shall conform to IS: 7098 part (2), 1985 with amendments. “Specification for cross linked polyethylene insulated PVC insulated cables.

3.2 Technical requirement

a) Specific requirement

3 core 6.35/11 KV grade, 90 Deg C rating, heavy duty power cable, with standard compacted circular aluminum conductor shielded with extruded semi-conducting compound cross linked polyethylene insulated, shielded with extruded semi-conducting compound and copper tape, shielded cores laid up with fillers inner sheath of extruded PVC, Galvanized round steel wire armoured and PVC ST-2 overall sheath.

b) Single core cables:

Single core, 6.35/11 grade, 90 deg. C and rating, heavy duty power cable with stranded compacted circular aluminum conductor, shielded with extruded semi-conducting compound, cross linked polythene insulated, shielded with extruded semi-conducting compound and a copper tape, inner sheath of extruded PVC, hard drawn aluminum round wire armoured and PVC type ST-2 overall sheath.

3.3 DESIGN CRITERIA:

i) The cables will be used for connection of the 8 MVA transformer and 6.6kV switchgear.
ii) The cable will be laid direct in ground/duct with uncontrolled backfill, with channels of logging.
iii) The cable shall be designed to withstand the mechanical, electrical and thermal stresses under steady and transient conditions.
iv) The conductor insulation shield, XLPE insulation and insulation shield shall be by triple extrusion process.

v) Core identification shall be by coloured strips or by numerals

4.0 CABLE DRUMS:

i) Cable shall be supplied on non-returnable seasoned, strong wooden drums. The wood pre-protective shall be applied on the entire drums.

ii) The cable ends on the drums shall be sealed with good quality heat shrinkable cable end seals.

4.1 CABLE LENGTH:

The cable length on the drum shall generally the specified so as to avoid unnecessary joint.

The normal delivery lengths shall be

1 core – 1000 sq mm	- 500 Mtr.
3 core – 95 sq mm	- 300 Mtr.
3 core – 240 sq mm	- 250 Mtr.
3 core – 400 sq mm	- 250 Mtr.

5.0 TESTS:

5.1 The cable supplied should have been already type test tested and reports furnished to the owner.

5.2 The owner reserves the right to witness the acceptance test.

5.3 The routine test reports should be approved by the owner.

6.0 CABLE LAYING:

6.1 The cable shall be laid generally as per the cable installation shall be as per IS: 1255-1983 section 3, clause 8 to 11 as per IS: 1255 – 1967 direct in ground except at the point of terminations where they shall be in air and at road crossing or drains where they shall be laid in stoneware pipes or cement concrete hume or spun pipes.

6.2 The excavation shall be open cut and its width shall be that minimum as is necessary for drawing the cable in the trench without causing any damage to the cable.

6.3 The minimum depth of laying from ground surface to the top of the cable shall be 0.9 m.

6.4 The excavated earth shall be stacked by the side of the trench itselfduly ensuring that the heaped earth does not cave into the trench.

6.5 Where trenching is done in loose soils which are prone to collapse, the side of the trench shall be shored with wooden planks or such other strutting so as to prevent the trench side from collapsing or caving in.

6.6 The bottom of the trench shall be filled with a sand cushion of no less than 50 mm in depth and the cable shall be laid over this cushion by being drawn steadily over cable rollers without any sharp bends and crossings. No surface damages shall be caused during laying to the cable the rollers shall preferably be of the wooden sheaved type free hand rollers.

6.7 The cable on being laid shall be provided around with another layer of protective sand cushion of not less than 75 mm and finally covered with cable tiles. The minimum bending radius shall not exceed indicated in clause 5.3 of IS: 1255-1967. The tiles shall be clay fired embossed with the words BWSSB. The trench shall finally be covered with the excavated earth and consolidated.

TECHNICAL SPECIFICATION FOR JOINTS AND TERMINATIONS SUITABLE FOR 11 KV CLASS XLPE INSULATED UNDER GROUND CABLE

1.0 QUALIFYING REQUIRMENTS FOR MANUFACTURERS

Please refer volume 1, section-I – IFB.

1.1 SCOPE:

This specification covers as brief, the manufacture, testing, inspection, packing & supply of heat shrinkable type power cable accessories, such as straight through joints, indoor and outdoor terminations suitable for the underground cables manufactured in general conformity to IS: 7098 part (2) – 1985.

i) The accessories shall be suitable for 3 core and single core 6.35/11KV grade XLPE insulated compacted circular aluminum conductor armoured and overall PVC sheathed underground cables.
ii) Definition: The term “accessory” shall mean straight through joints indoor/outdoor terminations used in cable power transmission systems.

2.0 SERVICE CONDITIONS:

2.1 The straight through joints shall be suitable for use with cables directly buried in ground.

2.2 The indoor terminations shall be suitable for use indoor/outdoor type switchgear cubicles.

2.3 The outdoor terminations shall be suitable for use in directly exposed to atmospheric conditions.

3.0 POWER SYSTEM PARTICULARS:

1) System voltage 11 KV
2) Highest voltage 12 KV
3) Neutral Effectively earthed
4) Frequency 50 Hz
5) Cross sectional area of conductor
   3 x 95 sq mm. Aluminum
   3 x 240 sq mm Aluminum
   3 x 400 sq mm. Aluminum
   3 x 1000 sq mm. Aluminum

6) Continuous rated current at 90 deg. C of cables (approx)

3 x 95 sq.mm.	200 Amps.
3 x 240 sq.mm	300 Amps.
3 x 400 sq.mm.	400 Amps.
3 x 1000 sq.mm.	650 Amps.

7) Maximum short circuit capability of cables

KA for one sec.	25 KA

8) Approx.overall diameter of cables.

3 x 95 sq mm.	62 to 64 mm
3 x 240 sq mm	80 to 82 mm
3 x 400 sq mm.	94 to 96 mm
3 x 1000 sq mm.	64 to 66 mm

4.0 STANDARDS:

4.1 The testing of the completed system of accessory with cable of heat shrinkable joints and terminations shall be in accordance with the standard, with latest amendments thereof and revisions.

i) IS 13573-1992: Joints and terminations of polymeric cables for working voltages from 6.6 KV up to and including 33 KV performance requirements and type tests with latest amendments.
ii) Accessories tested in accordance with any other recognized national/international standards are also acceptable.

5.0 DESIGN REQUIRMENTS:

5.1 The heat shrinkable accessory system shall be suitable for 6.35/11 KV grade, cross-linked polyethylene insulated and aluminum conductor (of specified area of cross section) underground cables.

The accessories should be compatible with the operating conditions of the cable and suitable for the service conditions. The accessory shall provide effective stress control, insulation and environmental seal and should have non-tracking properties, impervious to moisture and resistant to ultraviolet radiation.

5.2 STRAIGHT THROUGH JOINTS:

The joint shall provide for the following performance functions:

i) Electric stress control between the cable semi-conducting screen and over the ferrule.
ii) Continuity of armour.

iii) Reinstatement of cable insulation and screen, similar to cable construction.
iv) Environmental protection and moisture sealing.
v) Mechanical strength and protection.

5.3 TERMINATION:

The termination shall be designed to provide:

i) Electric stress control for the cable insulation shield terminus.
ii) Complete external leakage insulation between the cable conductor/conductors and earth.
iii) Sealing the cable against ingress of moisture and other atmospheric agencies.
iv) The entire core length from lug seal to cable break out shall have high voltage, non-tracking material.

5.4 The main components of the accessories shall be:

i) The internal insulating and external protective tubings.
ii) Stress control tubings.
iii) Anti-tracking and weather resistant tubing - indoor/outdoor.
iv) Break out/ Glove made from HV anti-tracking material.
v) Lug sealing sleeve made from HV anti-tracking material.
vi) Rain sheds made from HV non-tracking material.
vii) All other items like, lugs, ferules connectors, earth continuity material etc., necessary for a complete joints/termination.

6.0 TESTS

6.1 ROUTINE TESTS

a) Visual inspection
b) Dimension check
c) Physical verification of kit as per bill of materials.

SECTION 6.0: SWITCHYARD ERECTION

Clause No.	Particulars
1.0	General
1.1	Single insulator & hardware
1.2	Construction features
2.0	ACSR conductor
3.0	Galvanized steel wire
4.0	Tubular Bus conductor
5.0	Earthing Conductor
6.0	VOID
7.0	Bus post insulator
8.0	Earthing
9.0	Main Bus Bar
10.0	Bay equipments
11.0	Lightning protection.
12.0	Terminal Bay
13.0	Equipment Erection notes
14.0	Earthing
15.0	Directly Buried cables
16.0	Insulation of cables
17.0	Junction Box
18.0	Testing & commissioning

Annexure – A Testing procedure for ACSR DRAKE conductor.

Annexure – B Testing procedure for Galvanized steel earth wire.

TECHNICAL SPECIFICATION FOR SWITCH YARD ERECTION

1.0 GENERAL:

66kV station single bus arrangement with Drake conductor is proposed. The detailed scope of work includes design, engineering, manufacture, testing at work, supply on F.O.R. destination site basis, insurance, handling, storage, erection, testing and commissioning of various items, (along with its spares) as detailed herein.

This section covers the description of the following items:

- Stringing insulators and hardware
- ACSR conductor
- Galvanized steel earth wire
- Aluminum tubular bus bar
- Bus post insulators
- Earthing &Earthing materials.
- Lightning protection
- Cabling material, etc.,
- Bay marshalling box.

1.1 Stringing insulators & Hardware power connectors:

The insulators for suspension and tension strings shall conform to IS: 731, insulator hardware shall conform to IS: 2486

1.2 CONSTRCUTION FEATURES:

1.2.1 Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or strain strings. Each insulator shall have rated strength markings on porcelain printed and applied before firings.

1.2.2 Porcelain used in insulator manufacture shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly verified tough and impervious to moisture.

1.2.3 Glazing of the porcelain shall be uniform brown colour, free from blisters, burns and other similar defects.

1.2.4 When operating at normal rated voltage there shall be no electric discharge between conductor and insulator, which would cause corrosion or injury conductors or insulators by the formation of substance due to chemical action. No radio interference shall be caused when operating at normal rated voltage.

1.2.5 The design of the insulator shall be such that stress due to expansion and contraction in any part of the insulator shall not lead to deterioration. Ferrotis parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn – 99.95 as per IS – 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

1.2.6 Bidder shall make available data on all essential features of design including the method of assembly of discs and metal parts, number of discs per insulators, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for meeting expansion stresses, results in corona and thermal shock tests, recommended working strength and at special design or arrangement employed to increase life under service conditions.

1.2.7 VOID

1.2.8 Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion, or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

1.2.9 VOID

1.2.10 The tension string assemblies shall be supplied along with suitable turnbuckle sag compensation springs if required may also be provided.

1.2.11 All hardware shall be bolted type.

The following types of clamps are required
a) Tension type both for single and twin conductor.
b) Suspension type both for single and twin conductor.
c) Post insulator clamps – both for single and twin conductor.
d) Spacer clamp for twin conductor.

1.2.12 VOID

1.2.13 Tests:
In accordance with the stipulations under section – 2, the suspensions and tension strings, insulator discs and hardware shall be subjected to the following type tests, acceptance tests and routine tests.

1.2.13.1 Type tests on insulator strings:

a) Dry and wet power frequency voltages withstand test with corona control rings as per IS – 731.
b) Lightning impulse voltage withstand test (dry) with corona control rings as per IS – 731.
c) Voltage distribution test (D)

The string shall be energized with 100KV power frequency voltage. The voltage across each insulator unit shall be measured by using a high impedance voltmeter. The voltmeter shall be calibrated before and after the measurement.

d) Corona Test (Dry)

As per Annexure-A of Section-2.

e) RIV Test (Dry)

As per Annexure-A of Section-2.

f) Mechanical strength test

The complete insulator string along with its hardware strings shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS), which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for 5 minutes & then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2.13.2 Type tests on disc insulator

a) Thermal mechanical performance tests as per IEC 575 clause 3

1.2.13.3 Acceptance tests for disc insulators:

a) Visual examination
b) Verification of dimensions as per Cl. No. 10.5 of IS: 7.1
c) Temperature cycle test as per Cl. No. 10.6 of IS: 731
d) Puncture test as per Cl. No. 10.10 of IS: 731
e) Galvanizing test as per Cl. No. 10.12 of IS 731
f) Mechanical performance test as per IEC – 575 Cl. 4
g) Test on locking device for ball and socket coupling as per IEC 372 (2)
h) Porosity test as per Cl. No. 10.11 of IS: 731.

1.2.13.4 Acceptance test on hardware fitting

a) Visual examination as per Cl. 5.10 of IS: 2486 (part 1)
b) Verification of dimensions as per Cl. 5.8 of IS: 2486 (part- I)
c) Galvanizing /electroplating tests as per Cl. 5:9 of IS: 2486 (part – I)
d) Slip strength test as per Cl. 5.4 of IS: 2486 (Part – I)
e) Shore hardness test for the Elastometer (if applicable as per the value guaranteed by the bidder).
f) Mechanical strength test for each components (including corona control rings and arcing horns)
g) The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 1.2.13.1 (1) above should be followed.
h) Test on locking devices for ball and socket coupling as per IEC 372 (2)

1.2.13.5 Routine test disc insulator

a) Visual inspection as per Cl. no. 10.13 of IS: 731
b) Mechanical routine test as per Cl. no. 10.44 of IS: 731
c) Electrical routine test as per Cl. no. 10.15 of IS: 731

1.2.13.6 Routine test on hardware fittings

a) Visual examination as per Cl. no. 10 of IS: 2486 (Part – I)
b) Mechanical strength test as per Cl. no. 5.11 of IS: 2486 (Part – I)

1.2.13.7 Test during manufacture on all components as applicable on disc insulator

a) Chemical analysis of zinc used for galvanizing.

   Samples taken from the zinc ingot shall be chemically analysed as per IS : 209. The purity of zinc shall not be less than 99.95%

b) Chemical analysis, mechanical hardness tests and magnetic particle inspection for malleable casting.
   The chemical analysis, hardness tests and magnetic particle inspection for malleable casting will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be discussed and manually agreed to by the contractor and owner in quality assurance programme.

1.2.13.8 Tests during manufacture on all components as applicable on hardware fittings

a) Chemical analysis of zinc used for galvanizing:
Sample taken from the zinc ingot shall be chemically analysed as per IS: 209. The purity of zinc shall not be less than 99.95%

b) Chemical analysis, hardness tests and magnetic particle for forgings :
The chemical analysis, hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for the tests. The sampling will be based on head number and heat treatment batch
The details regarding tests will be as discussed and manually agreed to by the contractor and owner in quality assurance programme.

c) Chemical analysis and mechanical hardness tests and magnetic particle inspection for fabricator hardware:
The chemical analysis, hardness tests and magnetic particle inspection for fabricated hardware will be as per internationally recognized procedure for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be discussed and mutual and agreed to by contractor and owner in quality assurance programme.

1.2.14 PARAMETERS

1.2.14.1 DISC INSULATORS

	66 kV
a) Type of insulators	Fog type
b) Size of insulator units (mm)	255 x 145
c) Electromechanical strength	90 KN
d) Creepage distance of individual insulator units (minimum and as required to meet total creepage distance)	292 mm
e) Markings	Marking on porcelain shall be printed and applied before fitting.
f) Power frequency flashover voltage. puncture withstand Voltage.	1.3 times the actual wet

1.2.14.2 INSULATOR STRING

	66 kV
a) Power frequency withstand voltage of the complete string with corona control ring (wet) KV rms	140
b) Lightning impulse withstand voltage of string with corona control rings (dry) KVP	325
c) Total no. of discs per strings.	5

Note : For tension purpose, double insulator strings and for suspension purpose single suspension insulator string shall be used.

2.0 ACSR CONDUCTOR:

2.1 Details of conductor:

2.1.1 The contractor shall conform to IS: 398 (part – V) – 1982 except where other wise specified herein.

2.1.2 The details of the conductor are tabulated below :

	Drake	Lynx	Coyote	Rabbit
a) Stranding & wire diameter	26/4.442 mm Al + 7.3.454 mm steel	30/2.79 mm + 7/2.79 mm steel	26/2.54 mm Al + 7/1.91 mm steel	6/3.35 mm Al + 1/3.35 mm steel
b) Sectional area of Aluminum	402.9 mm sq.	183.4 mm sq.	131.7 mm sq.	52.9 mm sq.
c) Total sectional area	468.4 mm sq.	226.2 mm sq.	151.6 mm sq.	61.024 mm sq.
d) Overall diameter	28.13 mm	19.53 mm	15.89 mm	10.05 mm
e) Approximate weight	1624 kg/km	844 kg/km	521 kg/km	214 kg/km
f) Calculated DC resistance at 20 deg. C	0.0715 ohm/km	0.1589 ohm/km	0.2214 ohm/km	0.5449 ohm/km
g) Minimum UTS	14175 Kgs.	7950 Kgs.	4625 Kgs.	1860 Kgs.
h) Modulus of Elasticity (Kgs/Sq.cm x 10^6)	0.773	0.787	0.773	0.809
i) Co-efficient of linear Expansion / °C	18.99×10^{-6}	17.73×10^{-6}	18.99×10^{-6}	18.99×10^{-6}

2.2 WORKMANSHIP

2.2.1 The finished conductor shall be smooth, compact from uniform and free from all imperfections including spills, die marks, scratches, abrasions, scuff marks, kinks (protrusion of wires), dents, press marks, cut marks, wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, while rust powder formation or black spots (on account of erection with trapped rain water etc.,) dirt, grit etc.,

2.2.2 All the aluminum and steel strands shall be smooth, uniform and free from all innerfections such as spills and splits, die marks, scratches abrasions and kinks after drawing.

2.2.3 The steel strands shall be hot dip galvanized and shall have a minimum zinc coating of 260 gm/sq. mm after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfection and shall with stand minimum three dips after stranding in standard

prerce test. The finished stands and the individual wire shall be of uniform quality and have the same property and the characteristics as prescribed in ASTM designation: B498-74 and relevant IS.

2.2.4 The steel strands shall be perforated, and post formed in order to prevent the spreading of the strands in the event of cutting of composite core wire. Care shall be taken to avoid damage to galvanization during performing and post forming operation.

2.3 Joints in wires

2.3.1 Aluminum wires

No joints shall be permitted in the individual wire in the outermost layer of a finished conductor. However, joints in the 12 wire and 18 wire inner layers of the conductor shall be allowed but these joints shall be made by cold pressure butt-welded and be such that no such joints are within 15 Mtr. of each other in the complete stranded conductor.

2.3.2 Steel wire

There shall be no joints of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand splices in any length of the completed stranded steel core of the conductor.

2.4 Tolerance

The manufacturing tolerance to the extent of the following limits only shall be permitted in the diameter of individual aluminum and steel strands and lay-ratio of the conductor:

a) Diameter of Aluminum and steel strands:

	Standard	Maximum	Minimum
Aluminum	3.53 mm	3.55 mm	3,51 mm
Steel	3.53 mm	3.60 mm	3.46 mm

b) Lay ratio of conductor:

		Maximum	Minimum
Steel	7 wire layer	18	16
Aluminum	12 wire layer	14	12
	18 wire layer	13	11
	26 wire layer	12	10

2.5 Materials

2.5.1 Aluminum

The aluminum strands shall be hard drawn from electrolytic aluminum rods having purity not less than 99.5% and a copper content not exceeding 0.04%

2.5.2 Steel

The steel wire strands shall be drawn from high carbon steel wire rods and shall conform to the following chemical composition:

Element	:	% composition
Carbon	:	0.50 to 0.85
Manganese	:	0.50 to 1.10
Phosphorous	:	not more than 0.035
Sulphur	:	not more than 0.045
Silicon	:	0.10 to 0.35

2.5.3 Zinc:

The zinc used for galvanizing shall be electrolytic high grades zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS 209 -1979.

2.6 Standard length:

2.6.1 The conductor shall be supplied in standard length of 1500- 1800 meters as required. No joint shall be allowed within a single span of stringing.

2.7 Tests:

2.7.1 The following type acceptance & routine tests and tests during manufacturing shall be carried out on the conductor.

2.7.2 Type tests

The following type tests shall be conducted on samples of connection. The testing charges for the type test shall be charged separately in the prescribed schedule of the Bid.

a) UTS test on stranded Conductor	The no. of sample shall be mutually agreed between contractor and owner
b) DC resistance test on standard conductor	As per Annexure – A.

2.7.3 Acceptance Tests

a) Visual check, for joints scratches etc., and length of conductor	As per Annexure - A
b) Dimension checks on steel and Aluminum strands	
c) Check for lay ratios of various layers	- do -
d) Galvanizing test on steel strands	
e) Torsion and Elongation test on steel strands	
f) Breaking load test on steel and aluminum	

g) Wrap test on steel aluminum strands	))	IS : 398 (part V) 1982 clause 12.5.2, 12.7 & 12.8
h) DC resistance test aluminum strands	))	
i) UTS test on welded joints of aluminum strands	))	As per Annexure – A.

NOTE :
All the above tests except test mentioned at (i) shall be carried out on Aluminum and steel strands after stranding only.

2.7.4 Routine Tests :

a) Check to ensure that the joints are as per specification.

b) Check that there are no cuts, fins etc., on the strands.

c) All acceptance test as mentioned in clause 2.7.3 above to be carried on each coil.

2.7.5 Tests during manufacture

a) Chemical analysis of zinc used for galvanizing	))	
b) Chemical analysis of aluminum used for making Aluminum strands.	)))	As per Annexure – A.
c) Chemical analysis of steel & used for making steel strands)	)	

2.7.6 Sample batch for type testing

The contractor shall offer material for selection of sample for type testing. Only after getting quality assurance plans from owners quality assurance department.
The samples shall be manufactured strictly in accordance with the quality assurance plan approved by owner.

3.0 GALVANIZED STEEL EARTH WIRE

3.1 Details of Earth wire.

3.1.1 The galvanized steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IS: 398 (part – II) 1976 except where otherwise specified herein.

3.1.2 The details of the earth wire are tabulated below :

a)	Stranding and wire & Wire Dia.	7/3.15 mm steel
b)	Number of strands	
	Steel core	1
	Outer steel layer	6
c)	Total sectional area	54.55 mm sq.
d)	Overall diameter	9.45 mm
e)	Approximate weight	426 kg/km
f)	Calculated DC resistance at 20 deg. C.	2.95 ohms/km
g)	Minimum ultimate tensile	56.98 KN
h)	Direction of lay of outer layer	Right hand

3.2 WORKMANSHIP

3.2.1 All steel strands shall be smooth, uniform and free from all imperfections such as spills and splits, die marks, scratches, corrosions and kinks after drawing and also after stranding.

3.2.2 The finished material shall have minimum brittleness, as it will be subjected to appreciable vibration while in use.

3.2.3 The steel strands shall be hot dip galvanized (and shall have a minimum zinc coating of 275 gms/sq. m). The zinc coating shall be smooth, continuous of uniform thickness, free from imperfections and shall withstand three and a half dips after stranding in strand press test. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc the finished strands shall be of uniform quality and have the same properties and characteristic in ASTM designation B498-74.

3.2.4 The steel strands shall be performed and postformed in order to the prevent spreading of strands while cutting of composite earth wire. Care shall be taken to avoid damage to galvanization during performing and postforming operation.

3.2.5 To avoid susceptibility towards wet storage stains (while rust) the finished material shall be provided with a protective coating of boiled linseed oil.

3.3 JOINTS IN WIRES

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earth wire. There shall be no stand joints or stands splices in any length of the completed stranded earth wire.

3.4 TOLERANCES

The manufacturing tolerances to the extent of the following limits only shall be permitted in the diameter of the individual steel strands and any lay length of the earthwire.

	Standard	Maximum	Minimum
Diameter	3.66 mm	3.75 mm	3.57 mm
Lay length	181 mm	198 mm	165 mm

3.5 MATERIALS

3.5.1 STEEL

The steel wire strands shall be drawn from high carbon steel rods shall conform to the following requirements as to the chemical composition:

Elements	:	% composition.
Carbon	:	Not more than 0.55
Manganese	:	0.4 to 0.9
Phosphorous	:	Not more than 0.04
Sulphur	:	Not more than 0.04
Silicon	:	0.15 to 0.35

3.5.2 Zinc

The zinc used for galvanizing shall be electrolytic high grade zinc of 99.95% purify. It shall confirm to and satisfy all the requirement of IS: 209 – 1979

3.6 STANDARD LENGTH

3.6.1 The earth wire shall supplied in standard drum length of 1500 meters

3.7 TESTS

3.7.1 The following type, routine and acceptance tests and tests during manufacturing shall be carried out on the earth wire.

3.7.2 TYPE TESTS

The following type tests shall be conducted on samples of earth wire. The number of samples shall be mutually agreed between contractor and owner.

a) UTS test	)	As per Annexure – B.
b) DC resistance test	)	

3.7.3 ACCEPTANCE TESTS :

a) Visual check, for joints Scratches etc., and length of Earth wire	)	As per Annexure - B
b) Dimensional check	)	
c) Check for lay ratios of various layers	)	-do-
d) Galvanizing test	)	
e) Torsion test	)	
f) Elongation test	)	
g) Wrap test	)	
h) DC resistance test	)	IS : 398 (Part – III) 1976
i) Breaking load test	)	
j) Chemical analysis of steel	)	

3.7.4 ROUTINE TESTS :

a) Check that there are no cuts, fins etc., on the strands
b) Check for correctness of stranding.

3.7.5 TESTS DURING MANUFACTURE

a) Chemical analysis of zinc used for galvanizing	)	As per Annexure – B
b) Chemical analysis of steel	)	

3.7.6 SAMPLE BATCH FOR TYPE TESTING:

The contractor shall offer material for sample selection for type testing. Only after getting quality assurance programme approved by the owner. The samples for type testing shall be manufactured strictly in accordance with the quality assurance programme approved by the owner.

4.0 TUBULAR BUS CONDUCTOR

4.1 GENERAL: (Supply and erection)

4.02 This specification is in two parts, part-II and part - III in addition to part-I (general condition)

4.03 Part - II relates to technical specification in regard of manufacture, testing and supply of Aluminium pipes and accessories like post insulator clamps, corona bells, expansion joints etc.

4.04 Part - III relates to erection of aluminium bus bars with accessories supplied as per specification in part - II and includes bending, and welding of aluminium pipes, fixing corona, bells, making expansion joints etc.

4.05 The scope of this specification covers the erection of tubular aluminium bus bars as detailed below:

i) Erection of 110 KV or 66 kV main bus of 75 mm/ 63 mm, 33KV single main bus of 50 mm aluminium pipe with rigid cross bus connection to disconnects.

The scope of work covered by this specification is indicated in the layout plan drawings annexed . The main rigid bus is to be connected to the expansion type connectors of the disconnects through rigid cross bus aluminium pipes. Supply of terminal connectors of the disconnects, is not in the scope of supply.

4.06 VOID

4.07 The schedule of requirements is indicated in schedule of quantities, Volume II section - I General.

4.08 STANDARDS:

4.1 The materials offered shall conform to the relevant IS standards

4.11 Qualifying requirement : Refer Section IFB Volume I

4.12 The quantities and arrangement based on the drawing furnished by the purchaser may be altered by the successful bidder for ensuring better working arrangements with the written consent of the purchaser. The tenderer shall furnish reasons in detail for suggesting such alterations. The purchaser reserves the right to accept or to reject any or all of the

alterations or suggestions made by the bidder without assigning any reason whatsoever.

The following points shall be kept in view while submitting the offer:

a) The vertical connections from main bus bar to disconnects shall be as follows

i. The Y and 'V' tap shall be connected by bolted type clamp at top and bottom. Through a straight tap of height 1750mm and 1250 mm with 63 and 50 mm aluminium pipe in case of 110 KV and 66KV side bus connectors. The straight tap shall be connected by bolted type clamps both at top and bottom.

ii. Through a straight tap of height 1200 mm with 38 mm aluminium pipe in case of 33KV side bus connectors. The straight taps shall be connected by bolted type clamps both at top and bottom.

b) The horizontal connector from vertical tap to disconnects shall be of aluminium pipe of the same size as that of vertical connectors and be rounded off at the end.

c) Length of the horizontal connector from tap to disconnects is assessed, based upon the width of isolators of standard make. Hence there may be slight difference in the total length of horizontal connectors required, depending upon the make of disconnects which are being procured

4.13 OPERATING CONDITIONS

The materials supplied and the workmanship involved shall be suitable for operating conditions, which are detailed below

Particulars	66kV
Normal current to base handled	As per normal rating Al. pipes indicated in annexure
Impulse withstand voltage(KV)	325
Power frequency withstand voltage (KV)	140

4.14 DRAWING FOR APPROVAL:

Detailed layout drawings indicating the various components as detailed below shall be got approved by the successful tenderer before execution of work.

a) Aluminum pipes of various size.

b) Position of post insulator clamps indicating various types i.e., rigid expansion / sliding type.

c) Position of welds

d) Cross - section at vital points like welding points, connection of vertical taps of 110KV and 33 KV main bus bars, post insulators, clamps points rigid, expansion and sliding types.

e) Detailed drawings of various components namely length and cross section of pipes, straight taps, post insulators clamps, rigid, sliding, expansion clamps, aluminium pipe connectors 75 mm to 63 mm, 63 mm to 50mm, 50mm to 38mm used for connecting main bus bars to disconnects.

4.15 ALUMINIUM PIPE: (Supply of aluminium pipes and accessories)

4.16 The purchaser proposes to use the under mentioned nominal size of aluminium pipes

	66KV
Main busbars	63mm
Cross bus connecting main busbars and disconnects	50mm

4.17 Aluminium pipe to be supplied shall conform to BS-1600 schedule 40(EPS) standard pipe sizes or equivalent standard having mechanical and electrical characteristics as detailed in annexure-I.

4.18 The aluminium pipe to be supplied should be of aluminium alloy of type 6340 WP as per IS-5082 of 1981 and shall have the chemical composition and electrical characteristics as detailed in annexure-I and II respectively.

4.19 The requirement for total lengths of various sizes of aluminium pipe is indicated in section I of volume II. The tubes shall be supplied in convenient lengths so as to keep wastages to a minimum without diminishing any of the mechanical and electrical properties. The length of the pipes indicated is based on the drawings furnished. Any increase in lengths of pipes owing to any practical reasons, miscalculation will be to the account of the bidder.

4.20 The material shall be suitable for operating conditions detailed elsewhere ofthese specifications.

4.21 The aluminium pipes to- be supplied should withstand high temperature encountered during welding and no stress should develop in the pipe adjacent to the welding portion.

4.22 CORONA BELLS

4.23 These are required to be fixed at both ends of main buses to reduce corona effect.

4.24 The requirement of corona bells is indicated in the schedule of requirement.

4.25 SOLID CYLINDRICAL POST INSULATOR CLAMPS:

4.26 These are envisaged for holding the 220KV, 110KV, 66KV, and 33KV main bus supported on cylindrical type solid core post insulators. The clamps to be supplied shall be suitable for mounting holes on the insulator and size of the pipe which is detailed below :

Nominal diameter of Aluminium pipe (inches)	Cylindrical solid core post insulator	Pitch circle diameter of mounting holes on top (mm)	Number of holes (numbers)
i. 75 mm a 110KV main bus	As per IS 5350 Part II	127	4
ii. 63 mm a) 66KV main bus	As per IS 5350 Part II	127	4
iii. 50 mm a) 33 KV main bus	As per IS 5350 Part II	76	4

4.27 The clamps shall conform to latest edition of IS : 5561

4.28 The clamps required are of three types viz. Rigid, sliding and expansion types

i) RIGID TYPE CLAMPS: Are required to hold the aluminium pipe rigidly allowing for no lateral movement of pipe. These are required at points marked 'R' in the layout drawings and shall be suitable for insulator and aluminium pipe details indicated in clause 4.24. At all rigid clamp locations, there shall be vertical straight tap connections in case of 110KV, 66KV and 33KV main buses for connecting disconnects respectively.

ii) SLIDING TYPE CLAMPS: Are the ones located in between a rigid clamp and expansion type clamp, which shall allow for movement of pipes. These are marked as 'S' in layout drawing. These clamps may be bolted type or plain type i.e, without bolts. As in case of rigid type clamps, vertical straight line tap connections are located on sliding clamps also.

iii) EXPANSION TYPE CLAMPS : Are the ones located between two rigid clamps and marked 'E' in the layout drawing. These clamps are meant for allowing for expansion of aluminium pipes used for main bus. The

expansion joints so used in the clamps shall be complete in all respects with required aluminium straps, filler inserts, etc., and should allow for proper expansion of the portion of aluminium pipes between two rigid clamps.

4.29 ‘V’ OR 'Y' TAPS OR STRAIGHT LINE TAPS:

4.30 As detailed in clause 4.23 and clause 4.12 in part-I, the main bus is to be connected to equipment of various terminal bays by means of straight taps in case of 66kVmain buses.

4.31 The vertical taps are to be connected to disconnects by means of horizontal taps

4.32 The tap connections shall be with 50mm aluminium pipe for 66kV.

4.33 The height of vertical taps shall be 1250 mm for 66kV system.

4.34 The joints between the main bus and vertical tap and vertical tap to horizontal tap shall be made up of suitable clamps, which should conform to the latest edition of IS-5561.

4.35 WELDED JOINTS, INSERTS, ETC:

4.36 The main bus shall consist of standard lengths of aluminium pipe joined at various points by welded joints or expansion joints as the case may be.

4.37 Welded joints to an extent of 10% of the total quantity for each kV class shall be tested by radio-graphic test to prove the soundness of the weld joints. Further if desired by the owner, the tenderer shall arrange for the radio-graphic test of more number of joints for which the unit rates are to be indicated in price schedule.

4.38 The welded joint or the expansion joint shall be complete in all respects with required number of pipe filler inserts, proper welding etc.

4.39 The successful tenderer shall submit the quality assurance plan for the work and welder qualification for approval. The weld should be cut open to see the quality of the welds at no extra cost to the purchaser.

4.40 DRAWING

4.41 The tenderer should submit drawing in respect of all the components detailed in clause 1.00 to 5.00 and other essential and necessary components required for without which the tender will be rejected.

4.42 As stated in clause 6.00 of part-1 the tenderer shall submit drawings of various components for purchaser's approval. The material shall be offered for inspection only after purchaser's approval is accorded to the drawing.

4.43 The drawings of clamps and connectors **should be exhaustive**i.e, various views shall be depicted, and current rating (Ampacity) mentioned.

4.44 MATERIALS:

4.45 The material used for the various pipe joints, connectors shall be of proven tested quality and workmanship. The composition of alloys used shall be made available to the purchaser for verification. The bolts and nuts shall conform to IS-1363- 1967 with latest revisions.

4.46 The clamps offered shall be complete in all respect and shall perfectly suit the required size of aluminium pipes specified in clause 1.00 of part-II.

4.47 All ferrous metal parts like bolts, nuts of size l2mm and above shall be hot dip galvanized and bolt sizes below 12mm may be electro galvanized. The threads in nuts shall be cut after galvanizing and shall be lubricated and greased. All other threads shall be cut to take care of increase in diameter due to galvanizing.

4.48 All bolts shall be provided with a lock nut along with fastening nut.

4.49 All castingshall be free from blow holes and other casting defects such as cracks etc.

4.50 The connectors shall have the same electrical characteristics as the associated aluminium bus bars and, shall be capable of carrying the normal and short time current rating detailed in clause 5.00 of part-I.

4.51 Special care should be taken in clamp design to account for
(i) Galvanic corrosion,
(ii) cold flow or creep of aluminium,
(iii) thermal cycling.

The clamp body shall be of high conductivity aluminium alloy of high strength and non-corrosive. The aluminium alloy shall be copper free. The bolts and nuts used shall be of high tensile, non-corrosive galvanic resistant material. Aluminium alloy, phosphorous bronze or galvanized iron may be used as required by the clamp design.

4.52 Bolting pressure shall be well distributed. The outer surface of the clamp shall be smooth and free from sharp edges.

4.53 TESTS

4.54 Aluminiumpipe, associated clamps and corona bell shall be designed for trouble free operation in the climatic and atmospheric conditions enumerated in the project data. Hence, the tests and especially the Corona discharge test, Special features of design to meet the requirement shall be brought out in the tender.

4-55 TYPE TESTS: Tenderer shall furnish the following type test certificates in respect of the aluminium pipe and accessories.

	Aluminium Pipe	Clamps	Corona bells
1. Tensile test	----------	Applicable	----------
2. Resistance test	Applicable	Applicable	Applicable
3. Temp.rise test	Applicable	Applicable	Applicable
4. Short time current test	Applicable	Applicable	Applicable
5. Visual discharge test.	Applicable	Applicable	Applicable

4.56 Acceptance tests: The following acceptance tests are to be conducted in presence of owner's representative.
a) Tensile test.
b) Resistance test.
c) Temperature rise test.
d) Visual and dimensional verification

4.57 The visual discharge is specified to know the corona effect. Special care shall be taken to design and manufacture to minimise corona discharge. Corona discharge shall not be visible from the clamps when the system consisting of pipe with clamps is energised to phase ground system.

4.58 For the purpose of temperature rise and other tests, the current carrying capacity of various clamps may be reckoned as follows clamps or part thereof in contact with IPS aluminium pipe of nominal diameter.

a) 75 mm	2000 Amps.
b) 63 mm	1250 Amps.
c) 50 mm	1250 Amps.

d) 38 mm 800 Amps,

4.59 The purchaser reserves the right to conduct temperature rise tests at rated current on any erected portions of the bus works. Total temperature of clamps more than 85 deg C (temperature rise plus ambient) will not be acceptable. Clamps which are found to show the usual corona discharge at the rated voltage will not be acceptable

4.60 SAMPLES

4.61 The tenderer shall furnish typical samples of tubular bus bar materials of 500 mm. Minimum length and one unit of each of components like clamps, corona bell, power connectors, etc., used in the above works, to enable the purchaser to assess the quality of workmanship of the products.

4.62 ERECTION AT SITE

4.63 WORKS AND WORKMANSHIP:

To elaborate the work involved at site

i) It consists of cutting of tubular bus bars to required sizes.
ii) Making of straight tap.
iii) Welding of aluminium tubes after installation and mounting of tubular bus bars.
iv) Welding of heater plates
v) Bending and assembly of aluminium tubes with other accessories and equipments as shown in the tender drawings.
vi) Radiographic test of all welded Joints.

4.64 The workmanship shall be of highest order. The cutting shall be smooth, even without any burrs on the cut edges. The welding shall be perfect and the successful tenderer shall take radiographs and furnish the same to the purchaser to depict the perfect ness of welding,

4.65 WELDING OF JOINTS:

4.66 Surface to be welded shall be cleaned thoroughly so that the same are free from grease, dust and loose particles. Sleeves shall be used for welded joints under short circuit conditions.

4.67 Pure argon gas shall be used for welding. In view of argon gas shield around the arc, the welding operation shall be shielded from wind that could displace the gas envelope.

4.68 The welding process shall be carried out at the rate of 15-30 cms per minute. After completion of welding, the surface shall be cleaned.

4.69 The ' weld ' shall have an average strength ranging from 120 to 155 KG/cm^2.

4.70 TESTING AND COMMISSIONING

4.71 After satisfactory completion of works as detailed in clause 1.05 and 2.01 above, the tubular bus bars will be energized in the presence of the tenderer or his authorized representative.

4.72 TESTS

4.1 Radio - graphic tests:

a) The test is intended for the presence of the cracks, discontinuity in the welds.

b) A minimum of 10 % of the welded joints are to be subjected to radio-graphic tests. These welded Joints shall be selected at random by the purchaser.

c) Further if the purchaser desires for the radiographic test for more number of welded joints, the contractor shall arrange for the same.

4.2 Test to prove the mechanical strength ie, to withstand 155 KG/ cm^2 shall be conducted on 5% of the welded joints.

SL No.	Particulars	Unit	75 mm	63 mm	50 mm	38 mm
1	Nominal size	mm	75	63	50	38
2	Outer diameter	mm	88.9	73.03	60.33	48.26
3	Inner diameter	mm	77.92	62.71	52.51	40.89
4	Wall thickness	mm	5.449	5.16	3.91	3.68
5	Area of cross-section	Sq. mm	1439	1100	693.55	516.13
6	Weight per unit length	Kg/mtr	3.884	2.97	1.878	1.4
7	Section modules	Cubic cm	28.258	17.451	9.186	5.345
8	Movement of inertia	Cm^4	125.606	63.683	27.709	12.9
9	Radius of gyration	Cm	2.957	2.406	1.999	1.581
10	DC Resistance (max) at 20 deg C	Micro ohm/mtr	21.8	28.4	45.149	60.73
11	Reactance at 304.8 mm (1 foot) spacing at 50 Hz	Micro ohm/mtr	123.7	136.2	148.3	162.73
12	Current rating at 50 Hz for outdoor conditions	Amps	2350	1950	1440	1160

ANNEXURE -II

CHEMICAL PROPERTIES OF ALUMINIUM ALLOY

(Clause 10.03)

1.	I.S specification 5082-1981	6340-wp type or equivalent of any international standards.
2.	Chemical composition percentage	Cu - 0.04 Max Mg - 0.4 to 0.9. Si - 0.3 to 0-7. Fe- 0.5 Max. - 0.03 Min Al - remaining part
3.	Minimum 0.2% proof stress	16.5 Kg. Per Sq.rrm
4.	Minimum ultimate tensile strength	20.5 Kgs/Sq.mm
5.	Minimum elongation on 50 mm.	10%
6.	Electrical resistivity (max) at 20* C	1133 Micro ohms cm
7.	Minimum electrical conductivity	55% I.A.C.S
8.	Temperature co-efficient of resistance percentigade degree	0.00364
9.	Linear temperature co-efficient of expansion (20 deg C - 200 Q per centigrade degree	0.000023
10.	Thermal conductivity (Calories/sec/sq. mm/cm/deg. Q at 100 deg C	0.43
11.	Modulus of elasticity	6700 Kgs./sq.mm.

5.0 EARTHING CONDUCTORS

5.1 General

All conductors buried in earth shall be of mild steel. All conductors above ground level and earthing leads shall be galvanized steel, except for cable trench earthing. The minimum sizes of earthing, conductors to be used are as indicted in clause 8.4 this section.

5.2 Constructional features

5.2.1 Galvanized steel

a) Steel conductors above ground level shall be galvanized according to IS: 2629
b) The minimum weight of the zinc coating shall be 618 gm/sq.m and minimum thickness shall be 85 microns.
c) The galvanized surface shall consist of a continuous and uniformly thick coating of the firmly adhering to the surfaces of steel. The furnished surface shall be clean and smooth and shall be free from defects like discolored patches. Bare spots unevenness of coating, speller which is loosely attached to the steel globules, Spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

5.3 Tests:
In accordance with stipulations under section – 2 galvanized steel shall be subjected to four one-minute fips in copper sulphate station as IS: 2633

6.0 VOID

7.0 Bus POST INSULATORS

The post insulators shall conform in general to latest IS: 2544, IEC 168 and IEC – 815, IS – 5350

7.1 Constructional Features.

7.1.1 Post type insulator shall consist of a porcelain part permanently seemed in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to the operation of the associated equipment only solid core insulators will be acceptable.

7.1.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaw or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly verified, tough and impervious to moisture.

7.1.3.1 Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burns and other similar defects.

7.1.4 The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC – 815 for the specified pollution level.

7.1.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulator by the formation of substance produced by chemical reaction.

7.1.6 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

7.1.7 All ferrous parts shall be hot dip galvanized in accordance with latest edition of IS: 2633 & IS: 4579. The zinc used for galvanizing shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent smooth, reasonably bright continuous and free from imperfections such as flux, ash, rust, stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating coroning under the operating conditions.

7.1.8 a) Every bolt shall be provided with a steel washer under the nut so that part of the threaded portion of the bolts is within the thickness of the parts bolted together.

b) Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolts heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

c) All bolts and nuts shall be steel with well formed hexagonal heads forget from the solid and shall be hot dip galvanized. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.

7.1.9 Bidder shall make available data on all the essential features of design including the method of assembly of shells and metal parts number of shells per insulator, the manner in which mechanical stress are transmitted through shells to adjacent parts, provision for meeting expansion stresses results of corona and thermal shock, tests recommended working strength and any special design or arrangement employed to increase life under service condition

7.2 Tests

In accordance with the stipulations under section – 2 the post insulator shall be subject to type, acceptance, sample and routine tests as per IS: 2544 and IEC: 168

7.2.1 In addition to acceptance/sample/routine tests as per IS: 2544 and IEC – 168, the following tests shall also be carried out.

a) Ultrasonic test as an acceptance test.
b) Soundness test, metallurgical tests and magnetic test on MCI caps and pedestal tests as acceptance test.

c) All hot dip galvanized components shall be subject to check for uniformity of thickness and weight of zinc coating on sample basis.
d) The bending test shall be carried out at 50% minimum failing loads in four directions as a routine test and at 100% minimum failing load in four directions as an acceptance test.
e) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the quality plan.

7.2.2 The following type tests are proposed to be conducted on the post insulators. The test charge for conducting these tests shall be indicated in the offer.

a) Power frequency withstand test (dry & wet)
b) Lightning impulse test (dry)
c) Measurement of RIV (dry) – As per Annexure A, Section - 2
d) Corona extinction Voltage test (dry) – As per Annexure A, Section - 2
e) Test for deflection under load.
f) Test for mechanical strength.

7.3 Technical parameter of Bus post insulators:

a)	Type	Solid Core
b)	Voltage class (KV)	72.5
c)	Dry and wet One minute Power frequency withstand voltage (KV rms)	140
d)	Dry lightning impulse with stand voltage (KVP)	325
e)	Wet switching surge withstand voltage (KVP)	
f)	Max. radio interference voltage (in micro volts) at voltage 156 (rms) for 220 KV between phase to ground.	
g)	Corona extinction voltage (KV rms)	72.5KV
h)	Total minimum cantilever strength (KN)	6
i)	Minimum torsional moment	---- As per IEC – 273 ----
j)	Total height of insulator (mm)	770

k)	P.C.D.	
	Top (mm)	127
	Bottom	127
l)	No. of bolts	
	Top	4
	Bottom	4
m)	Diameter of bolt holes (mm)	
	Top	M16
	Bottom dia	16
n)	Pollution level as per IEC – 815	
o)	Minimum total creepage distance for Heavy pollution (mm)	1815

8 EARTHING

8.1 The earthing shall be in accordance with requirements given here under and drawing titled ‘Earthing details’ enclosed with the specification. The earth mat design is furnished by the owner and the work shall be carried out as per the design.

8.2 Neutral points of system of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

8.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian electricity rules, relevant Indian electricity rules, relevant in the locality where the system is installed.

a) Code of practice for earthing IS: 3043
b) Code of practice fort he protection of Building and allied structures against lightning IS: 2309
c) Indian electricity rules 1956 with latest amendments.
d) National electricity safety code IEEE – 80

8.4 Details of earthing system

Item	Size	Material
a) Main earthing conductor to be buried in ground		As per approved design & drawing
b) Conductor above ground of & earthing leads (for equipment)		As per approved design & drawing
c) Conductor above ground & earthing leads (for columns & aux. structures)		As per approved design & drawing
d) Earthing of indoor LT panels and outdoormarshalling boxes, MOM boxes, junction boxes & lighting panels etc.,		As per approved design & drawing
e) Rod earth electrode		As per approved design & drawing
f) Pipe earth electrode (in treated earth pit) as per IS 3043-2018	100 mm dia. 4150 mm long	C.I. pipe
g) Earthing for motors	25 x 3 mm GS flat	-------- do --------
h) Earthing conductor along outdoor cables trenches	50 x 6 mm MS flat	Mild steel

8.5 Earthing conductor Layout

8.5.1 Earthing conductors in outdoor areas shall be buried at least 600 mm below finished ground level unless stated otherwise.

8.5.2 Whenever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be re-routed in case it fouls with equipment/structure foundations.

8.5.3 Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure as per ‘Earthing details’

8.5.4 Earthing conductors or leads along their run-on cable trench ladder columns, beams, walls etc., shall be supported by suitable welding/cleaning at intervals of 750 mm. Wherever it passes through walls, floors, etc., galvanized iron sleeves shall be provided for the passage of the conductor, and both ends of the

sleeves shall be sealed to prevent the passage of water through the sleeves.

8.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.

8.5.6 Earthing conductors crossing the road shall be laid 300 mm below road or at greater depth to still the site conditions.

8.5.7 Earthing conductor embedded in the concrete shall have approximately 50 mm concrete cover.

8.6 Equipment and Structure Earthing

8.6.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with owner.

8.6.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc., shall be connected to the nearby earthing grid conductor by two earthing leads. Electrically continuity shall be ensured by bonding different sections of hand-rails and metallic stairs.

8.6.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

8.6.4 Metallic conduits shall not be used as earth continuity conductor.

8.6.5 A separate earthing conductor shall be provided for earthing lighting fixtures, receptacles, switches, junction boxes, lighting conduits etc.,

8.6.6 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc and steel reinforcement in concrete it shall be bonded to the same.

8.6.7 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc., shall be connected to the earthing conductor running along with the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.

8.6.8 Railway tracks within switchyard area shall be earthed at a spacing of 30 m and also at both ends.

8.6.9 Earthing conductor shall be buried 1500 mm away from the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid. As specified in earth mat design.

8.6.10 Flexible earthing connectors shall be provided for the moving parts.

8.6.11 All lighting panels, junction boxes, receptacles fixtures, conduits etc., shall be grounded in compliance with the provision of NBC & CEA Regulations.

8.6.12 A continuous ground conductor of 16 SWG wire shall be run all along each conduit run and bonded at every 600 mm by not less than two turns of the same size of wires. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, lighting fixtures etc., shall be connected to this 16 SWG ground conductor.

8.6.13 50 mm x 6 mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 Mtrs. The M.S. flat shall be finally painted with two coats of red oxide primer and two coats of post office red enamel paint.

8.7 Jointing

8.7.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surface shall be free from sales, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with and corrosive paint compound.

8.7.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red lead and afterwards coated with two layers bitumen compound to prevent corrosion.

8.7.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

8.7.4 Resistance of the joint shall be more than the resistance of the equivalent length of the conductor.

8.7.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

8.7.6 Bending of earthing rod shall be done preferably by gas heating.

8.7.7 All arc welding with large dia. Conductors shall be done with low hydrogen content electrodes.

8.7.8 The 50 x 6 mm GI flat shall be clamped with the equipment support structures at 1000mm interval.

8.8 Power cable Earthing

Metallic sheaths and armour of all multicore power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be called at switchgear end only.

8.9 Specific requirement for Earthing system

8.9.1 Each earthing lead from the neutral of the power transformer shall be directly connected to two pipe electrodes in treated earth pit (as per IS) which in turn, shall be burred in cement concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer like cooling banks, radius etc., shall be connected to the earthing grid at minimum two points.

8.9.2 Earthing terminal of each lightning arrester and capacitor voltage transformer shall be directly connected to rod earth electrode, which in turn shall be connected to station earthing grid.

8.9.3 Auxiliary earthing mat comprising of closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300 mm from ground level below the operating handles of the M.O.M. box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat.

9 Main Bus Bars

The brief description of the bus bar layout and equipment connection to be adopted are indicated in section – 1. The bus bar arrangements are shown in drawings enclosed with the bid documents.

9.1 The welds in the aluminum tubes shall be kept to the minimum and there shall not be more than one weld per span. The

procedure and details of welding shall be subject to owner's approval. Material for welding sleeve shall be same as that of aluminum tube. Welding sleeve shall be of 600 mm length.

9.1.2 Details of past experience of the persons proposed to be employed for Aluminum tube welding and the test reports of the welded pieces to prove the electrical and mechanical characteristics shall also be furnished along with the bid. Welding at site shall be done by adopting a qualified procedure and employing qualified welders as per ASME – section IX.

10 BAY EQUIPMENT

10.1 The disposition of various bay equipment is shown in single line diagram and layout drawings.

11 LIGHTNING PROTECTION

11.1 Direct stroke lightning protection (DSLP) shall be provided in the EHV switchyard by lightning masts and shield wires. The layout drawings enclosed indicate the tentative arrangement.

11.2 The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.

11.3 A 40 mm dia. 2750 mm long earth electrode with test links, CI frame and cover shall be provided to connect down conductor of lighting masts and towers with peak.

11.4 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

11.5 Down conductors shall be cleated on the structures at 2000 mm interval.

11.6 Connection between each down conductor and rod electrode shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level.

11.7 Lightning conductors shall not pass through or run inside G.I. conduits.

11.8 All metallic structures within a vicinity of 2000 mm in air and 5000 mm below ground shall be bound to the conductors of lightning protection system.

12 TERMINAL POINTS

The terminal points for the scope of work of switchyard are given below:

12.1 Line feeders

12.1.1 The transmission line shall terminate on line side gantry structure. The supply and erection of tension insulator string for line termination and tension clamps for earth wire termination are included in the scope.

12.1.2 Lightning protection down conductor at this end, tap offs and jumper connections from this dead end to all equipment in the switchyard are also in the Bidder’s scope.

13 EQUIPMENT ERECTION NOTES

13.1 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.

13.1.1 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing scratching by sling ropes etc.,

13.1.2 Handling equipment, sling ropes etc., should be tested periodically before erection for strength.

13.1.3 Bending of compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

13.1.4 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hacksaw shall not be used.

13.1.5 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.

13.1.6 All the equipment, instruments and auxiliaries required for testing and commissioning of equipment shall be arranged at site by the contractor.

13.2 STORAGE

13.2.1 The contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents.

The storage instructions of the equipment manufacturer/owner shall be strictly adhere to.

14 EARTHING MATERIAL

Cable Tags and Markers

14.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

14.2 The tag shall be of aluminum with the number punched on if and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS: 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

14.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate.

14.4 Location o underground cable joints shall be indicated with cable marker with an additional inscription “cable joints.”

14.5 The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meter and at every change in direction. They shall be located on both sides of road and drain crossings.

14.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing on each duct/conduit entry and at every twenty meters (20 m) in cable tray/trench runs cable tags shall be provided inside the switchgear, motor control centers, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

14.7 Storage and handling of cable drums

14.7.1 Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication the drums may be rolled in the same direction as it was rolled during taking up the cables.

14.8 Cable supports and cable tray mounting arrangements.

14.8.1 The contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures for the purpose of casting in the control room.

14.8.2 The supports shall be fabricated from standard structural steel members.

14.8.3 When the price components of the cable trenches includes providing cable trays and wherever the cables are to be supported with the use of cable trays, the insert plates shall be provided at an interval of 1500mm or as indicated in the tender drawing. If the price component of the cable trenches does not include the cost of cable trays and wherever the cables are to be supported without the use of cable trays, the insert plates shall be provided at an interval of 750mm

14.9 Cable termination and connections.

14.9.1 The termination and connection of cables shall be done strictly in accordance with cable and termination at manufacturer’s instructions, drawing and or as directed by the owner.

14.9.2 The work shall include all clamping fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable) connecting to cable terminal shorting and grounding as required to complete the job.

14.9.3 Supply of all consumable material shall be in the scope of contractor.

14.9.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

14.9.5 Control cable cores entering control panel/switchgear/MCCB/ MCC miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.

14.9.6 The contractor shall tap/ferrule control cable cores at all termination’s as instructed by the owner. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.

14.9.7 Spare cores shall be similarly tagged with cable numbers and coiled up.

14.9.8 All cable entry points shall be scaled and made vermin and dust proof. Unused openings shall be effectively closed.

14.9.9 Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the contractor for all power and control cables to provide dust and weatherproof terminations.

14.9.10 The cable glands shall also be tested as per 6121. they shall comprise of duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.

14.9.11 The cable glands shall also be tested for dust proof and weather proof termination. The test procedure has to be discussed and agreed to between owner and cable gland manufacturer.

14.9.12 If the cable end box or terminal enclosure provide on the equipment is found unsuitable and requires modification, the same shall be carried out by the contractor, as directed by the owner.

14.9.13 Crimping tool used shall be of approved design and make.

14.9.14 Cable lugs shall be tinned copper solderless crimping type conforming to IS: 8309 & 8394. Cable lugs shall be of approved make.

14.9.15 Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

15 DIRECTLY BURIED CABLES

15.1 The contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding soil cover, supply and installation of bricks or concrete protective covers, back filling and ramming, supply and installation of route markers and joints markers. The bidder shall ascertain the soil condition prevailing at site before submitting the bid.

15.2 The cable (power and control) between LT station, control room and DG set room and fire lighting pump house shall be laid in the buried cable trenches. In addition to the above, for lighting purpose also, buried cable can be used in outdoor area.

15.3 Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker.

16 INSTALLATION OF CABLES

16.1 Cabling shall be on cable racks, in built-up trenches, vertical shafts, excavated trenches for direct burial pulled through pipes and conduits laid in concrete ducts, run bare and clamped on wall/ceiling/steel structures etc., as shown in the drawings in detailed Engineering stage. Where specific cable layouts are not shown on drawings, contractor shall route these as directed by the owner.

16.2 The contractor shall fabricate and install mounting arrangements for the support and installation of all the cables on angles in the trenches as shown in the drawing, enclosed with specification. These mounting structures/cable racks shall be fabricated from structural steel members (channels, angles and flats) of the required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of chapter – structures, in addition to the specification given herein.

16.3 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminum paint. The red oxide and zinc chromate shall conform to IS: 2074. All welding works inclusive of the consumables required for fabrication and installation shall be in the scope of the contractor.

16.4 All interpole cables (both power and control) for all equipment, shall be laid in cable trenches conduit pipes of FB 50/100 mm diameter, class medium as per IS : 1239/part – I and IS : 4736 which shall be buried in the ground at a depth of 250 mm. The interpole cabling piping of breakers shall be laid in cable trenches. The scope shall include all labour, material, equipment for transporting, laying, burying etc., including required bends and end seals

16.5 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor, In the cable of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment on incase the distance is small, notch/opening on the floor shall be provided. In all these cases necessary bending radius as recommended by the cable contractor shall be maintained. Cabling in the control room shall done on ladder type cable trays.

16.6 Cables from the equipment to trench shall run in conduits. Necessary conduits of adequate size and length shall be supplied and installed by the contractor. Flexible conduit should be used between fixed conduit/cable trays (perforated type) and equipment terminal boxes, where vibrations are anticipated. The flexible conduit shall be as per the relevant IS.

16.7 Power and control cables shall be laid in separate tires. The order of laying of various cables shall be as follows for cables other than directly buried.

a) Power cables on top tires.
b) Control instrumentation and other service cables in bottom tires.

16.8 Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable.

16.9 Trefoil clamps for single core cables shall be of pressure die cast aluminum (LNP-6) Nylon – 6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc., these are required at every 2 meter of cable runs.

16.10 Power and control cables shall be securely fixed to the trays/supports with self-locking type nylon ties with de-interlocking facility at every 5 meter interval for horizontal run. Vertical and inclined cable runs shall be secured with 2.5 mm wide and 2 mm thick aluminum strip clamps at every 2 m.

16.11 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:

Table of cable and minimum bending radius.

Power cable – 12D
Control cable – 10D

D is overall diameter of cable

16.12 Where cables cross the roads, drains and rails tracks, these shall be laid in reinforced concrete or steel pipes buried at not less than one meter depth.

16.13 In each run some extra length shall be kept at a suitable point to cable one (for LT cables)/two (for HT cables) straight through joints to be made in case the cable develop fault at a later date.

16.14 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the owner. If straight through joints are unavoidable, the contractor shall use the straight through joints kit of reputed make.

16.15 Control cable terminations inside equipment enclosure shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.

16.16 Metal screen and armourof the cable shall be bonded to the earthing system of the station, wherever required by the owner.

16.17 Rollers shall be used at intervals of about two meters while pulling cables.

16.18 All due care shall be taken during unreeling laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.,

16.19 Cable ends shall be kept sealed to prevent damage.

16.20 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS: 1255 and other Indian standard codes of practices.

16.21 Wherever cable pass through floor or through wall openings or other partitions, wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the contractor at no extra charges.

16.22 Contractor shall remove the RCC steel trench covers before taking up the work and shall replace all the trench covers after the erection work in that particular area is completed or when further work is not likely to be taken up for some time.

16.23 Contractor shall furnish three copies of the report on work carried out in a particular week indicating cable numbers, date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modification are made.

16.24 Contractor shall paint the tray identification number on each run of trays at an interval of 10 m.

16.25 In case, the outer sheath of a cable is damaged during handling/installation, the contractor shall repair it at his own cost to the satisfaction of the owner. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost of the owner i.e. the contractor shall not be paid for installation and removal of the damaged cable.

16.26 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The contractor shall over the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

16.27 Tests on cable trays

The contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.

a) Test for galvanizing (Acceptance Test)
The test shall be done as per approved standards.

b) Deflection Test: (Type Test)

A 2.5 Mtr straight section of 300mm, 600mm wide cable tray shall be simply supported at two ends. A uniform distributed load of 76Kg / m shall be applied along with the length of the tray. The maximum deflection at the mid – span shall not exceed 7mm.

16.28 Conduits, pipes and duct installation.

16.28.1 Contractor shall supply and install all grid conduits, mild steel pipes, flexible conduits, hume pipes etc., including all necessary sundry materials such as tees, elbows, check nuts, bustling, reducers, enlargers, coupling cap, rupples, gland sealing fittings, pull boxes etc as specified and to be shown in detailed drawing. The size of the conduit pipe shall be selected on the basis of 40 % fill criteria

16.28.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts and threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be supplied at all field threaded portions.

16.28.3 All conduit/pipes shall be extended on both sides of wall /floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by contractor.

16.28.4 When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on each conduit to facilitate easy dismantling of two conduits.

16.28.5 Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. GI pull of adequate size shall be laid in all conduits before installation.

16.28.6 Each conduit run shall be painted with its designation as indicated on the drawings such that it can be identified at each end.

16.28.7 Embedded conduit shall have a minimum concrete cover of 50 mm.

16.28.8 Conduit run sleeves shall be provided with the bushings at each end.

16.28.9 Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end with the help of bushings. Bushings shall have rounded edges so as not to damage the cables.

16.28.10 Where embedded conduits turn upwards from a slab or fill the termination dimensions shown on the drawings, if any shall be taken to represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half of the arc length of the bend shall be embedded.

16.28.11 All conduits/pipes shall have their ends closed by caps until cables arc pulled. After cables are pulled, the ends of conduits pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.

16.28.12 For underground runs, contractors shall excavate and back fill as necessary.

16.28.13 Contractor shall supply unload store and install conduits required for the lighting installation as specified. All accessories fittings required for making the installation complete including but not limited to pull out boxes ordinary and inspection Tees and elbows chuck nuts male and female bushings (Brass or Galvanized steel), caps square headed male plugs nipples gland sealing fittings full boxes conduit terminal boxes, gaskets and box covers, saddle terminal boxes and all steel supporting work shall be supplied by the contractor. The conduit fittings shall be of the same material as conduits.

16.28.14 All unarmoured cables shall run within the conduits from lightning panels to lighting fixtures, receptacles etc.,

16.28.15 Size of conduit for lighting shall be selected as per the table given in the drawings enclosed with the bid documents.

16.28.16 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.

16.28.17 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

16.28.18 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn shall be securely fixed to the building steel by welding and to concrete or brickwork by grouting or by nylon rawl plugs. Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

16.28.19 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

16.28.20 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 38 mm.

16.28.21 Wherever conduits are along with cable trays, they shall be clamped to supporting steel at an interval of 600 mm.

16.28.22 For directly embedding in soil, the conduits shall be coated with an asphalt base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

16.28.23 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.

16.28.24 Conduits shall be kept, wherever possible at least 300 mm away from hot pipes, heating devices, etc., When it is evident that such proximity may reduce the service life of cables.

16.28.25 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

16.28.26 For long conduit run, pull boxes be provided at suitable intervals to facilitate wiring.

16.28.27 Conduit shall be securely fastened to junction boxes of cabinets, each with a lock nut inside and outside the box.

16.28.28 Conduits joints and connections shall e made thoroughly watertight and rust proof by application of a thread compound which insulates the joints. While lead is suitable for application on embedded conduit and red lead for exposed conduit.

16.28.29 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations of flattered surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.

16.28.30 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

16.28.31 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

16.28.32 Lightning fixtures shall not be suspended directly from the junction box in the main conduit run.

17 JUNCTION BOX

a) The contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc., required for erection are also included in the scope of the contractor.

b) Junction boxes having volume less than 1600 cubic centimeters may be installed without any support other than that resulting from connecting Conduits where two or more rigid metallic conduits enter and accurately position the box. Boxes shall be installed so that thie level plumbed and properly aligned to present a pleasing appearance.

c) Boxes with volumes equal to or greater than 1600 cubic cm, and smaller boxes terminating on less than two rigid metallic conduits or for other reasons not rigidly held, shall be adequately supported by auxiliary steel of standard steel shapes or plates to be fabricated and installed. The contractor shall perform all drilling, cutting, welding, shimming and bolting required for attachment of supports.

18.0 C-TYPE WEDGE, BOLTLESS CONNECTORS

18.1 SCOPE:

18.1.1 This specification covers the design, manufacture, testing & supply of C-Type wedge boltless connectors (fired wedge type/ wedge type with bolted mechanism etc) which are to be used for overhead lines and jumpers making connection from the main bus/auxiliary bus conductor to the station equipments and for connection between the main bus and auxiliary bus conductor and also for connection to terminal pads of different station equipments such as circuit breakers, CTs, PTs, isolators, Lightning Arresters, wave traps etc of different makes. The equipment required shall be complete with all components which are necessary or usual for their efficient performance and satisfactory maintenance.

18.1.2 Bi-metallic connector used for copper to ACSR conductor connections shall be aluninium alloy clamps with necessary cast in copper liners. T- connectors used between bus bars shall be of aluminium alloy. The connectors should suit the respective equipment in respect of bolting/fixing arrangement. The requirements/details/drawings/samples should be approved by owners.

18.1.3 The suitable size of Aluminium connectors/Bi-metallic connectors shall be used for making connection to the equipment terminals. These shall be wedge type. The surface of the clamp shall be smooth with all edges rounded off.

18.1.4 The T & PG connectors shall be cartridge fixed “C” wedge type conforming to latest version of ANSI-C119.4 (AA): extra heavy duty class tested. The connectors shall have maximum contact surface with the conductor, extremely low and stable contact resistance and minimum power loss. These shall maintain constant force within the

connection for the life of connector/clamp while compensating for thermal expansion or grip and increased life span.

18.2 SERVICE CONDITIONS:

All parts of fittings shall be suitable for use in atmospheric condition indicated elsewhere in the specification inherently resistant to atmospheric corrosion or be suitably protected against corrosion both during storage and in service. The connector shall be capable of withstanding dynamic and thermal stresses without any damage or deterioration.

- Annual average ambient temperature - 30°C
- Maximum ambient temperature: 54°C
- Maximum relative humidity: 85-100%
- Wind Pressure – 150 Kgs/Sq.mtrs. (Max).
- Environmental conditions: Tropical climate with polluted atmosphere.
- Operational altitude: Not exceeding 1000 meters.
- Average Rainfall 1000-3000/5000mm.

18.3 APPLICABLE STANDARDS:

IS Specification or any other equivalent authoritative standard. Except as modified by this specification, the conductor accessories to be supplied shall conform to the latest edition with amendments and revisions thereof the following Bureau of American National Standards, Inc, (ANSI).

The C-Type wedge boltless connectors - latest edition of ANSI C 119.4 - 2004 Standards.

18.4 MATERIAL REQUIREMENT & WORKMANSHIP:

18.4.1 **Material:**

The C-Type wedge boltless connectors shall be of high strength and high conductivity aluminium alloy. The same shall be suitable for use on all combinations of aluminium to aluminium, or aluminium to copper conductors.

The components shall be properly proportioned to minimize stress concentration, corrosion and deterioration by galvanic action.

18.4.2 **Workmanship:**

High quality workmanship shall be maintained in the process of manufacture of the C-Type wedge boltless connectors. They shall be free from sharp edges, burs and swarf. The contact surface of the C-Type wedge boltless connectors shall be uniform to provide effective contact with the conductors.

18.5 TECHNICAL REQUIREMENTS:

18.5.1 "C" TYPE FIRED WEDGE BOLTLESS CONNECTOR:

- The connector consists of tapered "C" shaped member and wedge that is made of aluminium alloy
- The connector should be bolt less and of wedge system.
- The "C" member should be provided with built-in spring tension to maintain constant pressure for a firm electrical contact.
- The connector shall be used for multiple combinations of solid/stranded AAC, AAAC, ACSR, Copper combination etc.
- Copper to copper connectors - the "C" member to be composed of aluminum bronze alloy and the wedge of copper alloy very close to pure copper.
- "C" member wedge shall be factory coated with an inhibitor containing abrasive particles to help clean the contact surfaces during installation.

18.5.2 UNIVERSAL DISTRIBUTION "C" TYPE BOLTLESS WEDGE CONNECTOR:

- The connectors are composed of a "C" member and a wedge.
- "C" & wedge are made of a Tin-plated copper alloy in a configuration that creates a spring action.
- They are recommended to connect conductors of Aluminium, copper, steel and their alloys.

18.5.3 The wedge type boltless connectors shall consist of C-member and wedge. The wedge shall be inserted at a speed (at a speed of 40m./sec approximately in case of fired wedge type) so as to be effective in abrading all sliding surface and disrupting surface oxide film to generate large number of contact spot in the electrical interfaces. The mechanical stresses during the wedge insertion shall cause plastic deformation of the C-Clamp and shall increase the geometrical conformation of the clamp to the conductor. An Oxidation inhibitor

shall be applied to the surface thereby elimination of oxidation of metallic surface. The normal current carrying capacity of clamp shall not be less than the specified in the specification. If the connectors are to be installed by Powder actuated tool using cartridges with explosive, valid explosive license issued by the Government of India/State Government should be posessed.

Clamps shall be corona free and shall carry an overload of at least 20% over the rated current. The connectors should be easily removable and reusable type. Reusable means that the connector may be removed from service and installed again. Prior to reuse, any instructions to be followed for reconditioning the reusable connector shall be furnished.

18.5.4 The wedge type boltless connectors of station equipments should be of universal type facilitating to take horizontal or vertical jumps.

18.6 TECHNICAL PARAMETERS:

a). Insulation level

Sl. No.	Technical Particulars	6.6kV	66kV
1	Nominal Voltage (kV).	11	66
2	Maximum System Voltage (kV).	12	72.5
3	BIL (Impulse) kV_{peak}.	75	325
4	Power frequency withstand voltage (wet) kV_{rms}.	28	140

b). Normal Current rating

Equipment terminal connectors: - The current rating of the connectors should be same as that of the equipments for which the connector is used

Connectors used for conductors: - The 'C' connectors should be designed to carry the same current as the conductor when same conductors are used. And the 'C' connectors should be designed to carry the current of higher size conductors when conductors of different size are used. The rated current for which the clamps/connectors is designed with respect to the specified reference ambient temperature shall also be indelibly marked on each component of the connector.

c). Short time current rating

The short time current rating of the connectors shall be as per relevant standards.

18.7 ADDITIONAL REQUIREMENTS:

18.7.1 **Identification:**

The C-Type wedge boltless connectors shall be identified with the manufacturer’s identification marks and catalogue numbers.

18.7.2 **Markings:**

For easy identification of the C-Type wedge boltless connectors shall have markings indicating that the connectors are suitable for station bus conductor/station equipments/transmission lines.

18.8 **INSPECTION**

The inspection may be carried out by the purchaser at any stage of manufacture. The successful bidder shall grant free access to the purchaser's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing boltless connector in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the purchaser informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

18.9 **PACKING AND FORWARDING:**

18.9.1 The “C” type wedge boltless connector shall be packed in wooden crates suitable for vertical / horizontal transport, as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for damage to the equipment during the transit, due to improper and inadequate packing. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Any material found damaged inside the packing cases shall be supplied by the supplier without any extra cost to the purchaser.

18.9.2 Each consignment shall be accompanied by a detailed packing list containing the following information.

a) Name of the consignee.

b) Details of consignment.

c) Destination

d) Total weight of consignment

e) Sign showing upper / lower side of the crate.

f) Handling and unpacking instructions.

g) Bill of materials indicating contents of each package.

h) One set of approved drawings and manual.

18.9.3 The supplier shall ensure that the purchaser before dispatch approves the packing list and bill of material.

18.10 INSTRUCTION MANUALS

Fifteen copies of the Fixing and Maintenance manuals in English shall be supplied for “C” type wedge boltless connector one month prior to dispatch of the equipment. The manual shall be bound volume and shall contain all drawings and information required for Fixing and Maintenance of the connectors.

18.11 SUBMISSION OF DRAWINGS:

6 sets of drawings for each item have to be submitted for approval before commencement of supply. Supplies shall not be commenced before approval of drawings. Non submission of drawing /receipt of approval shall not be linked with delivery schedule. Delivery schedule should be adhered to. Final drawings equivalent to the number of consignees for each item have to be supplied.

The drawing shall be complete in all respects. Detailed dimensions shall be furnished in each of the drawings. Full specification of the equipment such as material, weight, tensile strength, tolerance, chemical composition etc., shall be incorporated in each drawing.

Any defects noticed in the manufacture of the equipment during inspection or after receipt at destination have to be promptly set right by the contractor free of all cost to the owner.

The following shall be furnished with the offer.

a. The catalogues (in English) describing the items and indicating the Model/Reference number, Code Name/Across Flat dimension of the relevant die to be used for compression, conductor sizes and other relevant details.

b. Constructional features and material used for components and relevant technical literature.

c. Certification for Quality Assurance conforming to ISO 9001.

d. Dimensional Drawings of all items.

e. Type Test Reports which were conducted on C-Type wedge boltless connectors (Not older than 5 years)

18.12 SAMPLE STUDY:

Three samples of each item offered shall accompany the bid to facilitate analysis and evaluation.

18.13 TESTS:

All tests shall be conducted in accordance with latest edition of ANSI C 119.4 -2004 The following shall constitute the tests. Type test certificates of recent origin (not older than 5 years) for having conducted the tests should be furnished along with the quotation. In case the test certificates are older than 5 years, then the contractor shall conduct the same afresh at his own cost.

18.13.1 Type Tests:

a) Failing load test.
b) Electrical resistance test.
c) Heating cycle test.
d) Tensile strength test.
e) Torque strength test
f) Conductor damage test.
g) Short time current rating as per relevant standards.

18.13.2 Acceptance Tests:

a. Tensile strength test.
b. Electrical resistance test.
c. Dimensional check.

18.13.3 Routine Tests:

a. Visual examination.
b. Dimensional verification.

18.14 SPECIAL TOOLS AND TACKLES:

18.14.1 A set of special tools and tackles, which are necessary or convenient for fixing/connecting, removing and reusing of connectors shall be supplied.

18.15 DEVIATION FROM TECHNICAL SPECIFICATION:

Deviations, as compared to technical specifications, if any, shall be brought out in the relevant sheet enclosed. Any deviations other than that mentioned in relevant sheet WILL NOT BE CONSIDERED.

18.16 PERFORMANCE GUARANTEE:

The “C” type Wedge Boltless connectors offered shall be guaranteed for satisfactory performance for a period of 24 months from the date of satisfactory commissioning. The “C” type Wedge Boltless connectors found defective within the above guarantee period shall be replaced and supplied by the supplier free of cost within one month from the date of receipt of intimation.

18.17 GUARANTEED TECHNICAL PARTICULARS:

The bidder should furnish the guaranteed technical particulars as required in Annexure.

GUARANTEED TECHNICAL PARTICULARS FOR WEDGE:

TYPE BOLTLESS CONNECTORS

1. Manufacturer's name.
2. Applicable standards.
3. Type.
4. Material of connector.
   a. 'C' member
   b. Wedge
   c. Spring washers (if any)
5. Temperature rise above ambient Temperature
   a. At rated current.
   b. At 150% of rated current.
6. Rated current
7. Short time current rating.
8. a). Rated terminal load (Kg)
   b). Factor of safety.
9. Minimum thickness of any part.
10. weight of clamp complete (Kg)
11. Type test reports - enclosed.
12. OGA drawing - enclosed.

19.0 TESTING AND COMMISSIONING

19.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P/instruction of the equipment contractor or owner without any extra cost to the owner. The contractor shall arrange all instruments required for conducting these tests along with calibration certificate and shall furnish the list of instruments to the owner for approval.

19.2 GENERAL CHECKS

a) Check for physical damage.
b) Visual examination of zinc coating/plating.
c) Check from name plate that all items are as per order/specification.
d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.
e) For oil filled equipment check for oil leakage, if any. Also check oil level and top up wherever necessary.
f) Check ground connections for quality of weld and application zinc thick paint over weld and application of Zinc with paint over weld joint of Galvanized surface
g) Check cleanliness of insulators and bushings

h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code or erection
i) Check for surface finish or grading rings (Corona control ring).

19.3 STATION EARTHING

a) Check soil resistivity
b) Check continuity of grid wires.
c) Check earth resistance of the entire grid as well as various sections of the same.
d) Check for welded joint and application of zinc rich paint as galvanized surfaces.
e) Dip test on earth conductor prior to use.

2.2 TABULAR BUS WORK AND POWER CONNECTORS

a) Physical check for finish.
b) Electrical clearance check
c) Testing of torque-by-torque wrenches on all bus bar power connectors and other accessories.
d) Millivolt drop test on all power connectors.
e) Sag and tension check on conductors.

2.3 ALUMINUM TUBE WELDING

a) Physical check.
b) Millivolt drop test on all joints.
c) Dye penetration test & radiography test on 10% samples basis on weld joints.
d) Test check on 5% sample joints after cutting the weld piece to observe any voids

ANNEXURE "A"

(Testing procedure for ACSR DRAKE conductor)

1.0 UTS Test on stranded conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 80 KN and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall increased at a steady rate to 141.75 KN and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded. UTS tests on other types of ACSR conductor should be conducted to the parameters applicable as for IS.

2.0 VOID

3.0 VOID

4.0 DC Resistance Test on stranded conductor

On a conductor sample of minimum 5m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 deg. C as per clause no. 12.8 of IS: 398 (part V) 1982. The resistance corrected at 20^0C shall conform to the requirements of this specification.

5.0 Chemical Analysis of Zinc.

Sample taken from the zinc ingots shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

6.0 Chemical Analysis of Aluminum and Steel

Sample taken from the aluminum ingots / strands shall be chemically spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

7.0 Visual checks for joints, scratches etc.,

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints etc., and that the conductor generally conform to the requirements of this specification. The length of conductor wound on the drum shall be measured with the help of counter meter during rewinding.

8.0 Dimensional checks for steel and aluminum strands.

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

9.0 Check for Lay – ratios of various layers.

The Lay – ratios of various layers shall be checked to ensure that they conform to the requirements of this specification and clause no. 9.4 and 9.5 of IS - 398 (part – V) 1982.

10.0 Galvanizing Test

The test procedure shall be as specified in IS: 4826 – 1968. The material shall conform to the requirements of this specification.

1.0 Torsion and Elongation Tests on steel strands

The test procedure shall be as per relevant clause of IS: 398 (Part – V) 1982. In torsion test, the number of complete twists before fracture shall be less than 18 on a length equal to 100 times the standard diameter of the strand before stranding & 16 after stranding. In case test sample length of less or more than 100 times the standard diameter of the strand, the minimum number of twist will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 200 mm.

2.0 Breaking load test on welded Aluminum strands

Two Aluminum wires shall be welded as per the approved quality paln and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum breaking load of the individual Strand guaranteed by the bidder.

ANNEXURE "B"

(Testing procedure for Galvanized steel Earth wire)

1. UTS TEST

Circle perpendicular to the axis of the earth wire shall be marked at two places on sample of earth wire of minimum 5m length suitably compressed with dead end clamps at either end. The load shall be increased at steady rate up to 34 KN and held for a minute. The circles drawn shall not be distorted due to relative movement strands. Thereafter, the load shall be increased at a steady rate of 56.98 KN and held for one minute. The earth wire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and value recorded.

2. DC RESISTANCE TEST

On an earth wire sample of minimum 5m length, two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin with a predetermined bolt torque. The resistance shall be measured by a Kelvin double – bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The voltage

obtained shall be corrected to the value at 20deg. C shall conform to the requirements of this specification.

3. Visual Check for Joints, scratches etc., and length of earth wire

Earth wire drums shall be rewound in the presence of the inspector. The inspector shall visually check for joints, scratches etc., and see that the earth wire generally conforms to the requirements of this specification. The length of earth wire wound on the drum shall be measured with the help of counter meter during rewinding.

4. TORSION AND ELONGATION TESTS

The test procedure shall be as per relevant clause of IS: 398 (Part – V). The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in fraction, then it will be rounded off to the next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 200 mm.

5. DIMENSIONAL CHECK

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

6. LAY LENGTH CHECK

The length shall be checked to ensure that they conform to the requirements of this specification.

7. GALVANISING TEST

The test procedure shall be as specified in IS: 4826 – 1968. The material shall conform to the requirements of this specification.

8. CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING
Samples taken from zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

9. CHEMICAL ANALYSIS OF STEEL
Samples taken from ingots/coils/strands shall be chemically spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

SECTION – 7: STRUCTURES

Clause No.	Particulars
7.1	General
7.2	Lighting Masts void
7.3	Design drawings, Bill of materials and Documents
7.4	Fabrication of steel
7.5	Assembly
7.6	Bolting
7.7	Welding
7.8	Foundation Bolts
7.9	Stability of structures
7.10	Grouting
7.11	Galvanizing
7.12	Inspection before dispatch
7.13	Test certificate
7.14	Erection
7.15	Safety Precautions

1.0 GENERAL

1.1 The scope of specification covers fabrication, proto-assembly, supply & erection of galvanized steel structure of towers, girders, lightning masts & equipments structure. Towers, girders, lightning masts, support structure shall be lattice/tubular type structure fabricated from structural steel conforming to IS:2062 (latest). Single line diagrams are provided for lattice type towers/ girders/lightning mass. Bidder has to develop the structural drawing for the same based on the single- line diagrams and switchyard diagram. Based on the switchyard requirements like live- point height, phase to phase dimension and weight, dimensions of the equipment / post insulators, the supporting structures are to be designed by the successful bidder, which shall be approved by the owner. Lattice type structures are proposed for all equipments and tubular type is proposed for post insulators.

The scope shall include all types of structures include bolts, nuts, hangers shackles, clamps step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates angles & bolts for structure mounted or ground mounted marshalling boxes AC/DC Marshalling box & equipment control cabinets) and any other item as required to complete the job.

The connection of all structures to their foundations shall be by base plates embedded anchor/ foundation bolts. All steel structures & anchor/ foundation bolts shall be fully galvanized. Ile weight of the zinc coating shall be atleast 0.610Kg/sq m for anchor/ foundation bolts & for structural members. One additional nut shall be provided below the base plate, which may be used for the purpose of leveling.

1.2 Lighting masts

The lighting masts shall be fabricated as per owner's design and fabrication drawings lighting masts shall be provided with the structural steel ladder. The ladder shall be provided with protection rings. Platform shall be provided for mounting of lighting fixtures. The platform shall also have protection railing.

1.3 DESIGN DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

The towers beams and lightning masts shall be fabricated as per the single line diagrams furnished. In the part 1 of technical specifications, only the single line diagrams enclosed.

In respect of support (mounting) structures, the bidder has to quote as per the respective equipment structure designs. Successful bidder has to furnish the fabrication drawings based on the equipments to be supplied, heights to be maintained which shall be approved by owner. Only after getting the due approval of the owner the fabrication work shall be taken up.

1.3.1 FOR STANDARD STRUCTURES

a) Towers, Girders, Beams, Lightning masts, equipment support structures etc of 110KV/66KV class have all been standardized by the owner and fabrication drawings (structure assembly drawing) alongwith bill of material shall be provided by the owner for all these standard structures to the successful bidder after the letter of award based on which structures shall be supplied.

b) Contractor shall however not be relieved of his responsibility for the safety of the structure and good connections and any loss or damage occurring due to defective fabrication, erection or workmanship shall be borne by the contractor.

1.3.2 FOR STRUCTURES DESIGNED BY THE CONTRACTOR (To be referred only for structures for which design is included in the scope of the Contractor)

a) The Contractor shall furnish design, drawing and BOMs and shop manufacturing drawings for every member to the owner after award of the Contract. The design drawing should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints. In case owner feels that any design drawing, BOM are to be modified even after its approval, Contractor shall modify the designs and drawings and resubmit the design drawings, BOM as required in the specifications.

b) The fabrication drawings to be prepared and furnished by the Contractor shall be based on the design approved by the owner. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the owner. The fabrication drawings shall be submitted to the owner. Proto shall be made only after approval of fabrication drawings

c) Such approval shall, however, not relieve the contractor of his responsibility for the safety of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

1.3.3 The mass fabrication work shall start only after the final approval to the proto corrected fabrication drawing is accorded by the owner. Proto assembly shall be required to be carried out only for these structures that have not been proto-assembled by the fabricators for this contract or for earlier contracts from BWSSB. Wherever proto-assembly is not to be repeated, proto-corrected drawings shall be submitted directly with a note on the drawing stating that proto-assembly has been carried out under a particular previous contract.

1.4 FABRICATION OF STEEL:

1.4.1 the contractor shall bear the expenditure at all stage on account of loading unloading transportation and other miscellaneous expenses and losses and damages for all materials up to the fabrication yard shop and there-after to the erection site including all other expenses till the erection of work has been completed and accepted. The unit rates shall be deemed to be inclusive of all such incidental expenses and nothing extra shall be payable on any account in this regard.

1.4.2 The fabrication and erection shall be carried out generally in accordance with IS: 802 (latest). A reference however may be made to IS: 800(latest) in case of non-stipulation of some particular provision in IS: 802 (latest). All materials shall be completely shop fabricated furnished with proper connection material & erection marks for ready assembly in the field.

1.5 PROTO ASSEMBLY:

i) The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged & shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs & other suitable means & fasteners (bolts & welds) shall be placed in a balanced pattern. If the individual components are to be bolted paralleled & tapered, drifts shall be used to align the part so that the bolts can be accurately positioned.

ii) Sample towers, beams & lightening masts shall be trial assembled keeping in view the actual site conditions, before erection, in the fabrication shop & shall be inspected & approved by owner before mass fabrication. Necessary match marks shall be made on these components in the shop before disassembly & dispatching. For all structures, bill of materials alongwith proto connected fabrication drawing shall be prepared and submitted to owner as document for information. Such Bill of material, which shall be duly certified by the Contractor for its conformity to the drawing issued by owner shall be the basis for owner to carry out inspection.

1.6 BOLTING

i) Every bolt shall be provided with a spring washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

ii) All steel items, bolts, nuts & washers shall be hot dip galvanized.

iii) 2% extra nuts & bolts shall be supplied for erection-

1.7 WELDING:

The work shall be done as per approved fabrication drawing which clearly indicate various details of joints to be welded, type of weld, length & size of weld, whether shop or site weld. Symbols for welding on erection & shop drawings shall be according to IS: 8 13. Efforts shall be made to reduce site welding so as to avoid improper welding due to constructional difficulties.

1.8 FOUNDATION BOLTS:

1.8.1 Foundation bolts for the towers & equipment supporting structures & elsewhere shall be embedded in first stage concrete while the-foundation is cast. The contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

1.8.2 The contractor shall be responsible for the correct alignment & leveling of all steelworks on site to ensure that the towers/ structures are plumb.

1.8.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the contractor.

1.8.4 All foundation bolts shall be fully galvanized so as to achieve 0.61 Kg per.sq m. of zinc coating as per specifications

1.9 STABILITY OF STRUCTURE:

The supplier shall be responsible for the stability of the structure at all stages of its erection at site & take all necessary measures by the additions of temporary bracing's and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operation.

1.10 GROUTING:

The method of grouting the column bases shall be subject to approval of owner & shall be such as to ensure a complete uniformly of contact over the whole area of the steel base. The contractor will be fully responsible for the grouting operations.

1.11 GALVANIZING:

1.11.1 All structural steel works & single pipe supports shall be galvanized after fabrication as per IS:2629(latest) IS:4759 (latest).

1.11.2 Zinc required for galvanizing shall have to be arranged by the manufacturer. Purity of zinc to be used shall be 99.5% as per IS:209 (latest revision)

1.11.3 The contractor shall be required to make arrangement for frequent inspection by the owner as well as continuous inspection by a resident representative of the owner, if so desired for fabrication work.

1.12 INSPECTION BEFORE DISPATCH:

Each part of the fabricated steelwork shall be inspected certified by the owner or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the contractor of his responsibility regarding adequately & completeness of fabrication.

1.13 TEST CERTIFICATE:

Copies of all test certificates relating to materials procured by the contractor for the works shall be forwarded to the owner.

1.14 ERECTION:

The contractor should arrange his own erection plant & equipment, welding- set, tools tackles, scaffolding, trestles equipment's etc., & any other accessories & ancillaries required for the work. The erection work shall be started after concrete has acquired its full strength i.e, 14 days. The members shall not be subjected to any undue stress, damage to steel or galvanizing during erection.

1.15 SAFETY PRECAUTIONS:

The contractor shall strictly follow at all stages of fabrication, transportation & erection of steel structures, raw materials & other tools & Tackles, the stipulation contained in Indian Standard Code for erection for structural steel work as per IS: 7205. (Latest revision).

SECTION – 8: CIVIL WORKS

TECHNICAL SPECIFICATION FOR CIVIL WORKS

	PARTICULARS
1	General conditions and Guidelines
2	Site leveling
3	Foundation to station towers, equipments & other works
4	R.C.C. cable ducts, Cable Duct at Road crossings and R.C.C. Hume pipes Sub ducts
5	Anti-weed treatment
6	Jelly spreading
7	Road work
8	Culvert across approach Road
9	Baffle wall between Transformers
10	Chain link mesh security fencing and Security Compound wall
11	Main gate, Wicket gate and gate pillars
12	Construction of Oil storage sump tank
13	Yard protection works & storm water drainage

TECHNICAL SPECIFICATION FOR CIVIL WORKS

I. General Conditions and Guidelines:

The bidder shall go through the following guidelines and conditions thoroughly before quoting the rates for individual items of work.

1) Design, engineering and construction of all civil works at sub-station shall satisfy the general technical requirements specified in other sections of the specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this specification or implied as per National/International Standards.

2) All civil works shall be carried out as per applicable Indian Laws, standards and codes. All materials shall be of best quality conforming to relevant Indian standards and codes.

3) The contractor shall furnish all design (unless otherwise specified), drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the works in accordance with approved drawings, specifications and direction of owner.

4) The work shall be carried out according to the design/drawings to be developed by the contractor and approved by the owner or supplied to the contractor by the owner. For all buildings, structures, foundations etc., necessary layout and details shall be developed by the contractor keeping in view of the functional requirement of the equipments and facilities for providing enough space & access for operation, use and maintenance in due course by the owner. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the bidder shall quote according to the complete requirements.

5) The site will be handed over as “As it is where it is” condition. The layout and levels of all structure etc shall be marked by the contractor at his own cost from the general grid layout drawing and as per the benchmarks given by the Engineer-in-charge for checking of the layout and levels.

6) **Earth work excavation**: This includes excavation in all types of soil strata including hard rock and disposing of excavated surplus stuff after back filling to the places, shown by the Engineer-in-charge within the station premises or outside the premises of sub-station, to any notified disposal point of local bodies.

7) **Back filling and consolidation**: Back filling shall be done in layers of 250 mms thick for yard leveling & 150 mms thick for trenches backfilling duly watering and compacting to the required density. If the excavated earth is not suitable for back filling, then the approved new earth shall be brought from outside, mixed with 3% cement (only for casing below foundations / trenches backfilling) and shall be used for back filling. Back

filled earth & the sub-grade for the roads and embankment shall be compacted to minimum 96% of the standard Proctor's Density at OMC.

8) **Cement concrete mixing and laying**: The cement concrete shall conform to the requirement mentioned in IS-456 and all the test shall be conducted as per relevant Indian standard codes. The concrete shall be machine mixed and laid in layers of 150 mms thick and compacted using suitable vibrators to required shape. The bidder shall arrange for testing of concrete cubes at different stages of work as desired by the owner at his own cost.

9) **Cement**: The cement used shall be ordinary port land cement (OPC) of 43/53 grade and shall conform to relevant IS. The bidder shall produce test certificates for each lot of cement procured.

10) **Reinforcement steel:** Reinforcement shall be cold twisted deformed bars conforming to IS-1786 (Tor steel 40 grade) and in specific areas mild steel (Grade-I) conforming to IS-432 can also be used. Bidder shall produce test certificates issued by SAIL for each lot of reinforcement procured at site. Clear cover of 40 to 50 mm shall be left to the reinforcement from the external concrete surface.

11) **Jelly:** The jelly used shall be of hard broken granite/basalt/trap metal free from dust and organic material and shall be well graded. For bed concrete/leveling course (PCC 1:4:8) 40 mm and down size jelly shall be used and for coping, basement, cills, screed concrete, structural concrete, Design Mix etc (PCC/RCC 1:2:4, 1:3:6 & concrete M20 Grade) 20 mm and down size jelly shall be used.

12) **Sand**: white river sand free from clay and any other organic materials very well grained and cleanly sieved shall be used.

13) **Bricks:** Standard size table molded, well-burnt Bricks having minimum compressive strength of 45 Kgs per SqCms with neat edges shall be used. But in places where laterite stones are available the same may be used in place of bricks.

14) **Centering, formwork:** Only steel/plywood/plank centering shall be used for construction work. The centering material shall be discarded as soon as it losses its shape. Centering works shall be done to line and plumb with sufficient support to bear the dead weight of concrete and live loads during execution of work. The centering shall be water tight to avoid wheezing out of cement slurry during vibrating.

15) **Curing:** Curing shall be done for a minimum period of 10 days & maximum period of 28 days until the structures develops the required strength. The bidder shall construct a water storage tank for storing water and install 1 HP pump with distribution line for usage of water for construction & curing, as per the direction of Engineer-in-charge. The exposed faces of concrete shall be covered with gunny bags to keep the surface damp. The Max & Min period of curing may be decided with the

Engineer in charge of the work depending upon the importance and type of the structure& surface to be kept damp.

16) **Taxes**: Bidder shall note that all the applicable taxes viz., sales tax, income tax, royalties, GSTetc will be deducted out of the bills submitted for payment during the course of work as per the prevailing rates of Govt of India and Karnataka State Government.

17) Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the state), fire safety rules of Tariff Advisory committee, Water act for pollution control etc.

18) Foundation system adopted shall ensure that relative settlement shall be as per provision of IS-1904 and other Indian standards.

19) **Interaction**: The proper co-ordination and execution of all interfacing civil works activities like fixing of conduits in roofs/wall floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cutouts etc., shall be the sole responsibility of the contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

20) VOID.

21) The excess quantity of earth obtained from site leveling and from foundations and other works shall be filled in low laying areas of the station premises or transported to any notified areas of local body outside the station without any extra cost.

22) Bidder shall visit the site and shall obtain all required information regarding the availability of labour, materials, machineries etc., before submitting their offer. Any other additional information and details can be obtained from the concerned transmission offices of BWSSB. Any plea/request for the revision of rates owing to non-availability of the materials or insufficient quantity of materials will not be considered/entertained under any circumstances, which may please be noted.

II. SITE LEVELING:

SCOPE: - The scope of Site leveling work includes the following without any additional cost.

1) The bidder shall take the block levels of entire station area at an interval of 5 mtrs and plot the same marking contours at regular intervals. The block level drawing shall be submitted for approval along with calculations of cutting and filling quantities duly proposing the economical FGL of the yard.

2) Based on the above block levels,

3) the owner will decide the FGL to suit the requirement of station yard.

4) Clearing the site area free of bushes, trees including removal of roots, any unsuitable materials, demolition of any temporary building/structure and removal of debris/unserviceable materials, stacking within the premises or any disposal point away from the station area as per the decisions of the Engineer in charge of the work and stacking of useful/serviceable materials outside the yard within the station premises in the manner directed.

5) Leveling the station area to the required RL. The work includes cutting/excavating the areas above FGL in all types of soil and rock including soft rock, hard rock, hard laterite by blasting or chiseling, transporting the excavated earth to the areas lower than FGL, removal of roots, vegetation and other organic materials, breaking of clods, filling the areas lower than FGL in layers of 250mm loose thickness and consolidating the same using PRR to Proctors density of 96% to the required line, grade and cross section.

6) The shortage of earth if any shall be made good with the surplus earth from the foundation and other works. However if the earth is found shortage for leveling even after usage of all surplus available earth from all excavations, then such excess quantity of new earth brought from outside and used for site leveling only, will be paid at such rates provided in the price schedule for associated civil Engineering works or payment will be regulated as per the terms and conditions stipulated in the contract.

7) The excess/surplus earth & excavated rock shall be disposed off to the places within the station premises/stocked at the desired places or outside the premises to any notified disposal point of the local bodies as per the decisions & directions of the Engineer in charge of the work.

8) In the areas where the movement of roller is not possible, compaction shall be done using surface vibrators duly adding water to get the required density. Due care shall be exercised so as not to damage any foundation, structure, equipments etc during compaction.

9) If the type of soil encountered is black cotton soil/expansive soil or unsuitable for acceptance, then new approved earth/murrum brought from outside shall be spread to the entire switchyard area to a depth of 300mm (compacted thickness) excluding plinths of the structures, roads, drainage, buildings, cable ducts etc. and consolidated/compacted to proctors density of 96% to the line, grade and cross section after completion of casting of foundations and other works before Antiweed treatment and Jelly spreading. Payment for the use of new earth for site leveling will be regulated as stated under Sl.No. (6) above.

10) Bidder shall quote rate per CMTR to carry out:

(i) Site leveling – Cutting in all types of soil and rock and filling with available earth including compaction, disposal of surplus earth etc.

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(ii) Filling the yard with new / borrowed earth including compaction etc.

III. FOUNDATION TO STATION TOWERS, EQUIPMENTS AND OTHER SUCH WORKS

a) General:

1) Hard copy of the soil investigation report if available may be obtained from the concerned transmission office of BWSSB and if the same is not available the contractor has to carryout the soil investigation and the designs shall be based on the test report.

2) Work covered under this clause of the specification comprises the design, supply and installation of foundation and other RCC/PCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, fencing, control cubicles, bus supports, transformers, marshalling kiosks, auxiliary equipment and systems, buildings, tanks or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions**. The circuit breakers/reactor/transformer shall rest on block foundations only.**

3) Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes. **M20 grade concrete shall be used for construction.**

4) If the site is slopy, the foundation height will be adjusted to maintain the exact level at the top of foundation of the structures to compensate such slopes.

5) **The switchyard foundations' plinths and building plinths shall be minimum 300mm and 750mm above finished ground level respectively.**

6) **Minimum 75mm thick lean cement concrete 1:4:8 shall be provided below all underground structures, foundations trenches etc. to provide a base for construction unless otherwise specified.**

7) Concrete works done with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

8) The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The spread footings

foundation or pile foundation as may be required based on soil-sub-soil conditions and superimposed loads shall be provided.

9) If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or undreamed type as per relevant IS Code. Only RCC piles shall be provided. Suitability of the pile foundations adopted shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacities of piles have been established, the contractor shall take up the job of execution of pile foundation. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

b) Design:

1) **Foundation shall be of RCC type only.The design and construction of cement concrete structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20.** Higher grade of concrete than specified above may be used at the discretion of bidder, which has to be stated at the time of bidding. If the reinforcement is required the same shall have to be provided by the bidder without additional cost.

2) Limit state method of design shall be adopted unless specified otherwise in the specification. For design and construction of steel concrete composite beam IS: 11384 shall be followed.

3) For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. Cold twisted deformed bars (Fe=415 N/mm2) conforming to IS: 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade-I) conforming to IS: 432 can also be used. Two layers of reinforcement (one inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be 40mm In case of sidewalls of cable ducts and for tower foundations & equipment foundation, clear cover shall be 50mm.

4) RCC water retaining structures like storage tanks, cooling water basin etc. shall be designed as uncracked section in accordance with IS: 3370 (part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS: 3370 (part I to IV) by working stress method.

5) The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/ or super structure and other conditions, which produces the maximum stresses in the foundation or the foundation component, and as per the relevant IS Codes of foundation design. Detailed design

calculations shall be submitted by the bidder showing complete details of piles / pile groups proposed to be used.

6) All foundations shall rest below virgin ground level and the minimum depth of foundation below the virgin ground level shall be at least 500mm for equipment foundations and 1000 mm for towers, transformers and reactors.

7) Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

8) Necessary protection to the foundation work if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil, which is detrimental / harmful to the concrete foundations.

9) RCC columns shall be provided with rigid connection at the base.

10) All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS codes or as stipulated elsewhere in the specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

11) Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest, coefficient of active or possible earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

12) In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.

13) Following conditions shall be considered for the design of water tank in pump house, channels, sumps, trenches and other underground structures.

a) Full water pressure from inside and no earth pressure and ground water pressure & surcharge pressure from outside (application only to structures, which are liable to be filed up with water or any other liquid).

b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensued ignoring the superimposed loading.

14) Base slab of the any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

15) Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pump sump being empty for maintenance.

16) The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

17) **Machine foundations**:

a) All machine foundations shall be designed in accordance with the provisions of the relevant parts of latest revisions of Indian standards IS: 2974, IS: 456, IS: 2911. The provisions of DIN 4024 (latest) shall also be followed.

b) All block foundations resting on soil or piles shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequencies and amplitude criteria as lay down by the relevant IS codes and/or machine manufacturers, shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS: 456. & M 20 concrete shall be used for construction.

c) For the foundations supporting minor equipments weighing less than one tone or if the mass of the rotating parts is less than one-hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipments is to be supported on building structure, floors etc., suitable vibration isolation shall be provided by means of springs, neoprene pads etc. and such vibration isolation system shall be designed suitably.

18) **Other foundations:**

All foundations shall be designed in accordance with the provisions of the relevant parts of latest revisions of Indian Standards IS: 2911 and IS: 456. & M 20 concrete shall be used for construction.

i) Type of foundation system i.e., isolated or combined footing or raft or pilling shall be decided based on the load intensity and soil-strata.

ii) Minimum three piles shall be provided in any pile group, if required. The tower and equipment foundations shall be designed for a factor of safety of 2.2 for normal/broken wire condition and 1.65 for short circuit conditions.

c) Admixtures & Additives:

1) Only approved admixtures shall be used in the concrete for the works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labeled containers to enable identification.

2) Admixtures in concrete shall conform to IS: 9103. The waterproofing cement additives shall conform to IS: 2645. Concrete admixtures / Additives shall be approved by Owner.

3) The contractor shall use an approved neutralized vinsol resin air-entraining agent in all concrete. The air-entraining agent shall be supplied and batched as a solution with solids content not exceeding 15 percentages by weight with suitable, stable & consistent pH. Air – entraining requirements shall be in accordance with CP 100 part I.

4) The contractor may propose and the Owner may approve the use of water reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing, operating and shall only be approved as an aid overcoming unusual circumstances and placing conditions.

5) The water-reducing set-retarding admixture shall be an approved brand of ignosulphonate type admixture

6) The waterproofing cement additives shall be used as required / advised by the owner.

d) Hot Weather Requirement:

1) As per relevant code, during hot weather, precautions shall be taken to avoid premature stiffening of the fresh mix and to reduce water absorption and evaporation losses and when the temperature of the surrounding air is higher than 30 degree C; the following shall apply unless otherwise approved by the owner.

a) The formwork shall be continuously sprayed with cold water in advance of concreting and excess water shall be removed from inside the forms immediately prior to placement of concrete.

b) The reinforcement and the formwork (if metal forms are used) shall be protected from the effect of hot winds and direct sunlight.

c) Suitable barriers shall be provided to protect the freshly placed concrete from wind until the concrete is sufficiently hard.

d) The concrete when placed shall be maintained at a temperature of less than 30 degree C by the use of chilled water or by spraying the aggregate with cold water.

e) The concrete shall be mixed, transported, placed and consolidated, as rapidly as possible and shall then be covered with an impervious membrane or wet Hessian until moist curing begins.

f) Curing compounds shall not be used as an alternative to the requirements of (clause 8.10.3) curing.

g) During hot weather (atmospheric temperature above 40^0 C) or cold weather (atmospheric temperature at & below 5^0 C) the concreting shall be done as per the procedure set out in IS: 7861 (part I & II).

IV(a). R.C.C. CABLE DUCTS

1) Cable ducts shall be constructed by RCC of grade M 20 as per typical drawings furnished by the owner. RCC pre-cast cover slabs shall be provided for covering the top portion. At junction and where pre-cast slabs cannot be provided cast-in situ slabs may be provided.

2) The trench bed shall have a slope of 1 in 500 along the run and 1 in 250 perpendiculars to the run.

3) Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.

4) Water flow diagram to drain the storm water collected in the drain shall be prepared and got it approved. If the topography of the area permits the gravity flow, water collected in the drain shall be effectively discharged to the convenient point outside the station by providing 300mm dia. RCC Hume pipe NP2 class. If the site does not permit the gravity flow, then necessary RCC sumps shall be constructed, and suitable pumps installed to drain the water effectively through RCC Hume pipes & GI pipes as required. Cable trenches shall not be used as storm water drains. **No separate rate or extra rate will be paid for providing RCC Hume pipes or for construction of Sump, providing pump and pipelines for draining of water from the cable ducts.**

5) All metal parts inside the trench shall be connected to the earthing system.

6) All the construction joints of cable trench i.e., between base slab to base slab & the junction of vertical wall to base slab as well as from vertical wall to wall and all the expansion joints shall be provided with approved quality PVC water stops of approx. 230X5mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable ducts.

7) Cable ducts shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plastered with 12mm thick 1:6 cement sand mortar.

8) Rate per Rmtr. of duct shall be quoted. Rate shall include excavation in all types of soil and rock, backfilling with available earth or new earth, disposal of surplus soil/rock to the places directed, concrete= PCC 1:4:8 & M20 concrete, structural steel work- insert plate, cable support angles, cable trays, lugs etc., pre-cast or cast in situ RCC slabs, reinforcement, brick works, RCC hume pipe, GI pipe, Sump tank and other items of works not mentioned herein but required for the completion of work.

9) **In case of black cotton soil/expansive soil, well compacted murrum casing with 3% cement shall be provided below PCC 1:4:8,**

10) All mild steel parts shall be fabricated and neatly placed in position to plumbs and levels and welded as per drawing and painted with two coats of approved synthetic enamel paint over one coat of shop primer.

IV(b).R.C.C. CABLE DUCTS AT ROAD CROSSING:-(M 20 concrete)

The bidder shall quote rate per No. of duct crossing. Rate shall include cost of excavation, back filling, and disposal of surplus earth R.C.C. M20 grade for side walls, raft and top slab, PCC 1:4:8, reinforcement, tray supports, cable trays and allied works including cost of all materials as per technical specification and enclosed drawing in all respects.

1) The length of the crossing shall be to the full width of the road and section shall be kept as that of the duct for which the crossing is required.

2) The scope of work applicable to RCC duct specified under 4(a) is also applicable to cable duct crossing.

IV(c).RCC HUME PIPE SUB DUCTS

Bidder shall quote Rate per Rmtr of cable duct. Rate shall include cost of excavation in all types of soil and rock, backfilling and disposal of surplus earth/rock, supplying, providing and jointing RCC Hume pipes of 150mm dia. NP2 class/of required dia. with collars, GI/PVC pipes for taking cables from equipments to ducts/chambers, etc. as per detailed specification and directions of the Engineer in charge of work.

IV (d). INSPECTION CHAMBERS:

Inspection chambers of size 650x450mm / 450x450mm as required shall be provided wherever required as per layout and directions of Engineer-In-Charge of work. Rate per number shall be quoted. Work includes excavation, back filling and disposal of surplus earth / rock, bed concreting, brick masonry / laterite masonry walls, CI frame and cover, plastering etc., required for the completion of work as per specifications and directions of the Engineer-In-Charge of the work.

V. <u>ANTIWEED TREATMENT:</u>

The bidder shall quote rate per sq.mtr area including cost of all material and labour as per the technical specification detailed below:

1) The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawing, specification and direction of the owner/Engineer in charge.

2) The soil of the entire switchyard area shall be subjected to sterilization/Antiweed treatment before jelly spreading strictly as per instruction/requirement of the manufacturer of the chemical required for soil sterilization/Antiweed treatment. After all the structures and equipment have been erected and accepted and soil sterilization as specified is complete, the site shall be maintained to the lines and grades indicated in the drawing and rolled/compacted to form compact surface condition which shall be matching with finished ground level of the switchyard area.

3) The details of quantities and method of application of chemicals used for soil sterilization/Antiweed treatment shall be as per manufacturer's recommendations. Bidders are required to submit the details of chemicals proposed to be used and recommendations of manufacturer with required guarantee along with their bids for necessary approval of owner. Approval of owner by no means shall relieve the contractor from their contractual obligations as stipulated in **General and Special Conditions of Contract.**

<u>VI. JELLY SPREADING:</u>

Bidder shall quote rate per Sq. mtr of area for Jelly spreading. After the soil sterilization, material is applied and surface prepared/compacted to the required slope/grade, 100 mm thick layer of granite/basalt/trap jelly of 20mm size shall be spread over the area

marked in drawing for jelly spreading as per drawing and directions of Engineer in charge of work.

The material required for jelly spreading shall be free from all types of organic materials, flakes and shall be of standard approved quality and as directed by the owner.

The 20mm nominal size shall pass through IS sieve designation 40mm and nothing through 16mm IS sieve.
The area marked in the drawing (excluding buildings, pathways, roads, drains, cable ducts, equipment/structure plinths etc.) shall be covered with jelly.

The work shall be taken up after completion of all construction activities including Antiweed treatment.

VII . TRANSFORMER FOUNDATION, RAIL TRACK/ROAD CUM RAILTRACK:

The Contractor shall provide a permanent transfer track system integrated with the transformer foundation to enable installation and the replacement of any failed unit by the spare unit located at the site. The transformer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with integral radiators and oil, without the de-energization of any other equipment in the station. This system shall enable the removal of any failed unit from its foundation to a repair area and the installation of the spare unit. This system, preferably, shall not interfere with the normal internal road and trench system. If trench/drain crossings are required, then suitable RCC culverts shall be provided in accordance with IRC Code/relevant IS. Rail tracks shall be of RCC, minimum M20 grade. The space between the tracks shall be suitably filled with local sand and 75 mm thick PCC of grade 1:4:8 placed over sand filling. The top of PCC shall be up to the formation level. Suitable drainage system between the tracks shall be provided.

The rails shall be first quality 52 Kg/m medium manganese steel as per Indian Railway specification T-12-64 and its subsequent revision, joined together by fish plates as per Indian Railway specification T-1/57 and their drawing no.090 M and 27mm diameter fish bolts.

The Contractor shall provide a pylon support system for supporting the firefighting system.

VIII. ROAD WORK:

The approach road and road within the sub-station provided for access to equipments & building are in the scope of the bidder. The layout of the roads shall be based on general details and arrangement drawing for the Sub-station. Parking areas shall be provided for site personnel and visitors at convenient locations. Adequate turning space for

vehicles shall be provided and bend radii shall be set accordingly. Road to the transformer / reactors shall be as short and straight as possible. All Sub-station and approach roads be constructed so as to permit transportation of all heavy equipments.

NOTE:<u>When the length of the Road is more than 250 Mtr, Asphalt/Bitumen Rroad shall be provided and When the length of the Road is less than 250 Mtr, RCC road shall be provided.</u>

1) The double lane road shall have minimum 5M black topping/RCC with 1.6M wide shoulders on either side of the road. The other service roads shall be with 3.75M black topping/RCC and 1.3M wide shoulder on either side of the road. **<u>The finished top (crest) of roads shall be 200mm (min) above the surrounding grade level (formation level).</u>** Road construction shall be as per IRC standards. Adequate provision shall be made for road drainage.

2) Approach road from the nearest P.W.D. main road up to the proposed Substation is also in the scope of the contract.

3) All the culverts and its allied structure (required for road/rail, drain trench crossings etc.) shall be designed for class AA loading and checked for Class A loading as per IRC standard.

4) All roads shall be designed for class 'E' of traffic as per IRC Standards.

8) Excavation shall be done in all types of soil & rock to the required cross section, line and grade. Longitudinal gradient and cross slope/camber shall be provided to dispose off the rainwater to the nearby drains.

9) The excess/surplus earth shall be disposed off to the places directed as per the directions of the owner.

i. <u>Asphalt/Bitumen Road</u>

1) The bidder shall quote rate per Rmtr of road including cost of forming the approach, laying 3 layers of graded metal, spreading of murrum, watering, consolidation using road roller and forming the shoulders on either side, providing and fixing RCC kerb stones and walkways if the space is available, providing chip carpet with seal coat including cost of all materials, labours etc., complete as per technical specification and enclosed drawing

2) The macadam road shall consist of sub-base (with 90mm size jelly of consolidated thickness of 200mm including 25 mm thick murrum layer) and base course in two stages each of consolidated thickness of 75mm with murrum packing (1st stage with 63 – 40 mm size jelly and 2nd stage with 40-25 mm jelly).

3) Block top shall consist of 50mm thick B.U.S.G. (Built up spray grout) and 25mm thick pre-mixed chip carpet. The work shall be carried out as per MOST specification incorporated in the KPWD Schedule of Rates.

4) For road in expansive/ BC soil, a consolidated/compacted thickness of murrum/new earth 450mm thickness below sub-grade and 250 mm for shoulders shall be provided. RCC Kerb stones (M20 Grade) shall be provided on either side of the road and fixed as per the drawing. The exposed faces of the kerb stone shall be painted with two coats of approved synthetic enamel paint (Black & Yellow stripes as per IRC standards shall be provided).

ii.RCC ROAD

RCC Road (M20 Grade) shall be provided as per the drawing furnished.

1) The bidder shall quote rate per Rmtr of road including cost of forming the approach, providing a consolidated/compacted thickness of murrum/new earth 300mm thick with 3 %cement (for expansive soil/black cotton soil) providing walk ways/shoulders using available approved earth or approved new earth (in expansive/BC soil), providing PCC 1:4:8 100mm thck, providing RCC M20 Grade 150mm thick, providing required reinforcement as per drawing, providing RCC Kerbs on both sides, providing two coats of synthetic enamel paint to the exposed faces of the Kerb (Black and yellow stripes) etc to complete the work in all respects

.

2) The RCC road shall consist of 100mm thick PCC 1:4:8 plain concrete using 40mm and down size jelly, 150mm thick RCC (M20 Grade) with required reinforcement as indicated in the drawing.

3) For road in expansive/ BC soil, a consolidated/compacted thickness of murrum/new earth 300mm thickness with 3% cement below PCC 1:4:8 and 250 mm for shoulders shall be provided. RCC kerb stones (M20 Grade) shall be provided on either side of the road and fixed as per the drawing. The exposed faces of the kerb stone shall be painted with two coats of approved synthetic enamel paint (Black & Yellow stripes as per IRC standards shall be provided).

IX. BAFFLE WALL BETWEEN TRANSFORMERS

GENERAL: Fire protection wall shall be provided in accordance with Tariff Advisory Committee (TAC) recommendations.

APPLICATION CRITERIA: A fire wall shall be erected between the transformers / reactors it the free distance between the various pieces of equipment is less than 10m. to protect each one from the effects of fire on another.

FIRE RESISTANCE: The fire wall shall have a minimum fire resistance of 3 hours. The partitions which are made to reduce the noise level of the transformer / reactor shall have the same fire resistance where the partitions are also used as fire walls. The walls of the building, which are used as fire walls, shall also have a minimum fire resistance of 3 hours.

The fire wall shall be designed in order to protect against the effect of radiant heat and flying debris from an adjacent fire.

MECHANICAL RESISTANCE: The fire wall shall have the mechanical resistance to with stand local atmospheric conditions. If this wall shall serve as a support for equipment such as insulators etc., its mechanical rigidity must be increased.

Connecting the walls by steel or other structures, which may produce a reversing torque, if overheated, shall be avoided.

DIMENSIONS: The fire wall shall extend at least 1m on each side of the power transformer / reactors and at least 1 m above the conservator tank or safety vent.

These dimensions might be reduced in special cases, and if TAC permits so, where there is lack of space. A minimum of 2-meter clearance shall be provided between the equipments i.e., transformer / reactors and fire walls.

The building walls, which act as fire walls, shall extend at least 1 m above the roof in order to protect it.

MATERIALS: The fire wall may be made of reinforced concrete (M-20 grade) fire brick, concrete blocks or corrugated iron on a steel structure as per the system requirements. Materials used must conform to the standards of the National Fire Prevention Association and TAC norms.

The exposed surface shall be painted with two coats of waterproof cement painting over one coat of primer.

The bidder shall quote rate per No.

X (A).<u>CHAIN LINK MESH SECURITY FENCING</u>:

The bidders shall quote rate per "Rmtr" of securing fencing including supply and
erection / fixing of RCC fencing poles (vertical / bent up and struts), chain link mesh, barbed wire, GI flat, bolts and nuts, including cost of all materials labour etc., complete as per technical specification and enclosed drawings.

1) The security fencing shall be provided as per the layout drawing and to the areas as per the directions of the Engineer in charge of the work.

2) The security fencing poles shall be of RCC (1:1.5:3 prop) and of size 0.15 mtrs x 0.15 mtrs and length as per drawing cast at site using 12 mm and downsize jelly and approved clean sieved sand. The reinforcement shall be 4 numbers of 12mm dia. TOR steel vertical bars at corners and 8 mmdia. TOR stirrups at 20 cm C/C including cost of making holes wherever required as per design.

3) <u>Poles shall be erected at a spacing of 2.5 mtrs C/C with strut poles at all corners in both directions. Two transverse stay poles shall be provided at every 25 mtrs intervals and at every change in levels.</u>

4) The chain link mesh shall be of galvanized iron in accordance to specification covered under IS 2721.
   a) Size of mesh : Inter links of 50 mm x 50mm
   b) Size of coated wire : 8 gauge (4.06 mm thick)
   c) Width of chain link mesh : 2500 mm
   d) Class of zinc coating : As per IS standards

5) Above chain link mesh, 3 rows of galvanized barbed wire with loops as shown in drawing shall be provided.

6) The barbed wire shall consist of two splices per reel. The barbed wire shall be formed by twisting twoline wires, one containing the barbs. The barbed wire shall be of 12 SWG galvanized steel with its weight 155-136 gm/m length of the wire. Distance between two barbs shall be 75 mm. The barbs shall carry four points and shall be formed by twisting two point wires each two turn tightly round one line wire, making altogether over complete turn. The barbs shall be furnished in such a way that the four points are set and locked at right angles to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The points shall be sharp and well pointed. The barbed wire shall have tensile properties as below;

   - Breaking load of line wire: Minimum 216 Kg / Maximum 302 Kg.
   - Minimum breaking load of:
   - Complete barbed wire: 444 Kg.

   On the results of these additional tests, the whole or portion of the barbed wire shall be accepted or discarded by the owner, as the case may be.

7) Fence fabric shall not be installed until concrete is cured for a minimum period of 7 days.

8) The chain link mesh shall be stretched tightly to line and plumb all along the fencing and fixed to the security fencing poles using 50x6mm thick galvanized flat and galvanized bolts and nuts of size 16mm dia. 230mm long.

9) The fencing poles shall be painted with 2 coats of waterproof cement paint of approved color over 1 coat of cement primer.

XI (B): TOE WALL: Size stone masonry toe wall shall be provided for the security fencing as per the drawing enclosed. Work includes excavation, back filling and disposal in all types of soil / rock, PCC 1:4:8 bed concreting, providing new earth mixed with 3% cement for back filling and casing below foundations in expansive / BC soil, size stone masonry in cement mortar 1:6 for foundation and basement, PCC 1:3:6 for copping and embedding the RCC fencing poles, pointing to the exposed faces of stone masonry etc., complete as per drawing and directions of Engineer-In-Charge of the work. Rate / Rmtr. of TOE wall shall be quoted.

XII. MAIN GATE, WICKET GATE & GATE PILLARS:

1) The Gate frame shall be made of medium duty MS pipe conforming to relevant IS with welded joints.

2) The gates shall be fabricated with welded joints to achieve rigid connections. The gate shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint.

3) Gates shall be fitted with approved quality iron hinges, latch and latch catch. Latch and latch catch shall be suitable for attachment and operation of pad lock from either side of gates. Hinges shall permit gates to swing through 180 degree back against fence.

4) Gates shall be fitted with galvanized chain hook or gate hold back to hold gates open. Double gates shall be fitted with center rest and drop bolt to secure gates in closed position.

5) Work shall be carried out as per the drawing and directions of the Engineer-In-Charge of the work.

6) The bidder shall quote rate for carrying out the entire job.

XIII. CONSTRUCTION OF OIL STORAGE SUMP TANK

The bidder shall quote rate per No. Work includes, cost of earth work excavation for foundation in all types of soil and strata including hard rock, bed concrete, construction of size stone masonry wall, pointing to the exposed faces of wall, plastering to the inside faces of the wall with cement mortar using water proof compound, R.C.C cover slab and connection from transformer to sump tank using suitable size G.I. pipes with necessary G.I. specials and valves. Work shall be carried out according to detailed specifications. The rate includes cost and conveyance of all materials, labour etc., complete.

1) Earth work excavation shall be done to the required depth as per design in all strata.

2) Bed concrete shall be of 1:4:8 proportions

3) Size stone masonry shall be with granite/trap/basalt size stone built in cement mortar 1:6 proportion.

4) The coping concrete shall be of 1:2:4 proportions.

5) The flooring shall be with PCC 1:2:4 and finished with 20mm thick 1:4 cement mortar using waterproof compound.

6) The walls and the bottom of the slab shall be finished with cement mortar 1:4 proportion 20 mm thick with waterproof compound.

7) The roof slab shall be of R.C.C (M.20) with necessary reinforcement as per the drawing and one inspection chamber with frame and cover & locking arrangement as per directions shall be provided.

8) The pipe connections between transformer and the sump tank shall be provided with required diameter G.I. pipes with necessary G.I. specials as per directions of the Engineer in charge of the work.

9) Heavy duty Gate valve shall be provided at suitable location and for easy accessesability& operation during emergency & kept in the manhole chamber with locking arrangements.

10) GI ladder shall be provided for usage during maintenance as per directions of the Engineer-In-Charge of the work.

XIV. YARD PROTECTION WORKS AND STORM WATER DRAINAGE

Scope of the work includes for Design, Engineering and Construction of size stone masonry or RCC retaining wall, Size stone masonry or RCC drain and Size stone masonry or dry pitching with size stone masonry toe wall.

Items of the work involved in the job and quantities are furnished in the schedule. Bidders shall develop the designs and drawings to suit the site requirements in consultation with the owner and shall start commencement of work after approval of the designs and drawings by the owner.

Retaining wall or Pitching as required shall be constructed along the boundaries and in between the levels to retain earth filling/cutting as per requirements and directions of the owner.

Size stone masonry or RCC drain as required shall be constructed all along the boundaries and along the approach road. Necessary gradient shall be provided to ensure that silting is minimized and water flows freely. Final discharge point shall be located in consultation with the Engineer in charge of the work.

SECTION – 9: CONTROL AND RELAY PANELS

CLAUSE	PARTICULARS
1.00	SCOPE.
2.00	BRIEF DESCRIPTION OF PROJECT.
3.00	STANDARDS.
4.00	SYSTEMS DETAILS.
5.00	AUXILLARY SUPPLY.
6.00	TYPE OF PANEL.
7.00	CONSTRUCTIONAL FEATURES.
8.00	MOUNTING.
9.00	PAINTING.
10.00	WIRING.
11.00	TERMINAL BLOCKS AND TERMINAL CONNECTORS.
12.00	SPACE FOR CONTROL CABLE AND CABLE GLANDS.
13.00	MIMIC DIAGRAMS.
14.00	NAME PLATE AND MARKINGS.
15.00	INTERNALLY MOUNTED EQUIPMENTS,
16.00	FUSES.
17.00	EARTHING.
18.00	INDICATING LAMPS.
19.00	TEST TERMINAL BLOCKS.
20.00	CONTROL SWITCHES,
21.00	SYNCHRONIZING SWITCHES.
22.00	PUSH BUTTON SWITCHES.
23.00	SYNCHRONIZING EQUIPMENTS.
24.00	ANNUNCIATION SYSTEM.
25.00	INDICATING AND INTEGRATING EQUIPMENTS.
26.00	RELAYS.
27.00	PROTECTION SCHEME.
28.00	PROTECTION PHILOSOPHY
29.00	DARWINGS AND LITERATURES
30.00	TESTS, TEST CERTIFICATES AND INSPECTION

ANNEXURE-CRP-ANW
ANNEXURE-CRP-1
ANNEXURE-CRP-2
ANNEXURE-CRP-3
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ANNEXURE-CRP-5
ANNEXURE-CRP-6
ANNEXURE-CRP-7
ANNEXURE-CRP-8

ANNEXURE-CRP-9

TECHNICAL SPECIFICATION FOR CONTROL & RELAY PANELS FOR 66kV SUB-STATIONS

1.00 SCOPE:

1.01 This Technical specification covers design, manufacture, inspection, testing at works and supply of control and relay panels, annunciation equipments, synchronizing trolley and other miscellaneous equipments for 66kVSub-Stations of BWSSB grid.

1.02 The equipment should conform in all respects to the relating standards and shall be manufactured to the highest quality of Engineering, design and workmanship. The equipment manufactured shall ensure satisfactory and reliable performance throughout the service life.

1.03 The equipments offered shall be complete in all respects. Any material / component / accessories not specifically stated in this specification, but which is otherwise necessary for trouble free operation of the equipment specified in this specification shall be deemed to be included unless excluded expressly. All such components/ accessories shall be supplied at no extra cost.

1.04 The design and manufacturing shall be such that the equipment / components/ accessories of the same type and of identical rating shall be interchangeable. Likewise similar or corresponding parts/ components or accessories thereof shall also be interchangeable.

1.05 Wherever and whenever a material or article or component is specified or described by the name of a particular brand or manufacturer or vendor, the specific item mentioned shall be understood as establishing type, function and quality and not as limiting competition. However, tenderers are invited to offer other similar equipments/components/accessories provided they meet with the required standards, design, duties and performance.

1.06 All equipments offered shall confirm to type tests and shall also be subjected to acceptance and routine tests in accordance with the requirements stipulated herein. The purchaser reserves the right for conducting any or all of the type tests in accordance with the relevant standards. Such type tests shall be done free of cost. Where type tests have already been conducted, the tenderer shall submit copies of the same along with tender. The type tests certificates should however be not older than five years as on the date of bid opening. Any extra cost for repeating the type tests shall be indicated in the relevant price schedules.

2.00 **BRIEF DESCRIPTION OF PROJECT:**

2.01 The details of the project are as per Annexure enclosed.

2.02 The protection to be provided for various lines, transformers etc., shall be as follows:

i. Main protection i.e. distance scheme and differential scheme shall be of fast acting numerical type.

ii. Back up protection shall be of electromagnetic type.

2.03 There may be changes in components ordered as per purchase order and as per approved drawing. However, subsequent inspection and supply of panels shall confirm to the approved drawing.

3.00 **STANDARDS:**

Unless specified otherwise, equipment covered by this specification shall confirm to the Indian Electricity Rules and to the latest editions of relevant Indian Standards, British or American or other equivalent standard. In the event of supplies confirming to other equivalent international standards, the salient features of comparison shall be brought out in the tender. One copy of such standard specification in English language shall be enclosed with the tender. A general reference list of standards is furnished as follows:

Sl. No.	Particulars	IS	BS	IEC
1	Application guide for electrical relays for protection and other relays	3842	142	50
2	Electrical relays for power system	3231	----	60255-part 1 to 23.
3	Current transformers	2705	----	----
4	Voltage transformers	3156	----	----
5	Push buttons and control switches (LV switching devices for control and auxiliary circuits)	6875	----	----
6	AC electricity meter	722	----	----
7	Static protective relay	8686	----	----
8	Indicating instruments & recorders	----	89/90	----
9	Fuses	2203	88	66
10	AC static watt hour meter for active energy	----	---	686
11	Colours for ready mixed paints and enamels	5	----	---
12	Ready mixed paints, brushing, finishing exterior and semi glass for general purpose white	127	----	----

13	Paints, finishing interior white	641	----	----
14	Direct acting indicating analogue electrical measuring instruments and their accessories	1258 part: 1-5 7-9	----	----
15	Degree of protection provided by enclosures for low voltage switch gear and control gear.	2447	----	-----
16	Performance tests for protective scheme used in protection of light gauge steel against corrosion	4177	----	----
17	Communication protocol	--	--	60870-5-101/104
18	Numerical relay	--	--	61000
19	Sub-station automation	--	--	61850
20	Environmental testing	--	--	68
21	Insulation co-ordination for equipment with low voltagesystem	--	--	664

4.00 CLIMATIC AND GEOGRAPHICAL CONDITIONS:

4.01

Sl. No.	Particulars	
1.	Altitude	No exceeding 1000 Mtrs.
2.	a) Max. ambient air temperature	50 deg.C
	b) Average daily ambient air temperature	35 deg.C
3.	Minimum ambient temperature	5 deg. C
4.	Relative humidity	10-100%
5.	Average annual rainfall	1000 to 3000mm / 5000mm
6.	Average period of rainfall in a year	5 months
7.	Maximum wind pressure in Kg/Sq. mt.	150
8.	Isoceraunic level	46

4.2 The climate is moderately hot, tropical climate conducive to rust and fungus growth.

4.3 The climatic conditions are given to indicate wide range of variation in ambient conditions.

4.4 All electrical devices shall be tropicalised and given fungicidal treatment. They shall also be capable of satisfactory operation under the hot and humid climatic conditions that would prevail at the site.

4.5 All the equipments, contacts, etc., shall be designed to withstand seismic acceleration equivalent 0.3 g. Air conditioning is not available in the control room.

5.00 **SYSTEM DETAILS**:

5.01 Following is salient particulars of the system.

Sl. No.	Particulars	66 kV
1	Nominal system voltage (kV)	66
2	Highest system voltage (KV)	72.5
3	No. of phases	3
4	Frequency (Hz)	50
5	Method of grounding	Effectively earthed

5.02 The relays and meters shall be suitable for operation at 1 Amp Current Transformer secondary and 110V phase to phase and 63.5 volts phase to neutral, secondary voltage of the Voltage Transformer.

6.00 **AUXILIARY SUPPLY:**

6.01 The Purchaser shall make separate arrangement for providing low tension AC & DC power supply for control and auxiliary use. The tenderer shall give in his tender the estimate for AC & DC power required for the equipment covered by this specification.

6.02 The auxiliary supply voltage available is as follows:

Sl. No.	Particulars	Details
1	Power devices (like drive motors etc.)	415V, 3 phase, 4 wire, 50Hz AC supply with one point grounded
2	AC control and protective devices	240V, 1 phase, 2 wire, 50 Hz AC supply with one point grounded
3	DC for alarm, control and protection devices	110V for 66kV Sub-Stations - 2 wire ungrounded DC supply from batteries and battery charger. The ripple content in the DC supply from the charger will be less than 2%

The above supply voltage may vary as follows:

1	AC supply	Voltage variation +10% to –30% Frequency variation ± 5% Both variations may occur simultaneously or independently
2	DC supply	+10% to –20%

6.03 Each of the foregoing supplies will be made available by purchaser at one terminal point for each equipment for operation of accessories and auxiliary equipments. In case of 110V, AC supply is required, the tenderer shall include adequately rated 415/110V control transformers for each equipment. Bidders scope of supply shall include distribution beyond the points of supply, including supply of interconnecting cables between instruments and terminal blocks.

7.00 **TYPE OF PANEL:**

7.01 VOID

7.2 SIMPLEX PANEL (For panels of 66kV sub-stations):
Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from rear. In case of panel having width more than 800mm, double leaf – doors shall be provided with pad – lock.

8.00 **CONSTRUCTIONAL FEATURES:**

8.01 Control & Relay Board shall be of panels of duplex / simplex design, It is the responsibility of the bidder to ensure that the equipments specified and such unspecified complementary equipment required for completeness of the protective/ control schemes be properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed.

8.02 The panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP -31 in accordance with IS:2147.

8.03 Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, Cold rolled sheet steel of thickness not less than 3mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, and resistance to vibration and rigidity during transportation and installation.

The dimensions of the control and relay panels shall be as given below:

Height - 2312 mm including base channel height of 102mm.

Depth - 610mm

Width - 700/ 1000 mm.

8.04 All doors, removable covers and panels shall be provided with gasket all around with neoprene gaskets. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

8.05 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt heads appearing from outside, with all exterior surfaces smooth.

8.06 Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti-vibration strips made of shock absorbing materials, which shall be supplied by the bidder, shall be placed between panel & base frame.

8.07 Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/ station through a flexible braided copper conductor rigidly.

8.8 Relay panels of modern modular construction would also be acceptable.

8.9 The purchaser reserves the right to order the panels in full or part of the quantity indicated in the annexure. However, the breakup will be station – wise.

8.10 The offer shall include dummy panels and filler plates wherever necessary to have continuous formation. However, the purchaser reserves the right to order the dummy panels and filler plates.

9.00 **MOUNTING:**

9.01 All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipments on front of panel shall be mounted flush with only their bezels projection.

9.02 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

9.03 The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The center lines of relays, meters and recorders shall be not less than 450 mm from the bottom of the panel.

9.04 The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise, the top lines of all meters, relays and recorders etc.., shall be matched. The control switches of breakers and isolators shall be located on the mimic diagram corresponding to the exact position of the control equipment in the single line diagram.

9.05 Final arrangement of control instruments & relays shall be as per the drawing approved by the purchaser.

9.6 No equipment shall be mounted on the doors.

9.07 At existing station, panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement of equipment (center lines of switches, push buttons and other equipment) on the front of the panel.

9.08 All the equipment connections and cabling shall be designed and arranged to minimize the risk of fire and damage which may be caused by fire.

9.09 If any cutouts are left blank for mounting of future equipment, it shall be properly blanked off with metal plates, and wires left shall be properly insulated or terminated to a terminal block.

10.00 **PAINTING:**

10.01 All sheet steel work shall be phosphated in accordance with the IS: 6005 “Code of practice for phosphating iron and steel”.

10.02 Sheet steel shall be sand blasted to remove rust and scale, oil grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

10.03 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with a slightly alkaline hot water and drying.

10.04 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

10.05 The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.

10.06 The panel exterior shall finally be painted with two coats of synthetic enamel paint, each coat applied by stoving. The colour of the finishing paint shall generally be "opaline green" corresponding to shade No. 275 of IS-5 for panel exterior. All cubicle interiors shall be painted white, so as to give a contrasting effect with cubicle wiring

10.07 Each coat of primer and finished paint shall be of slightly different shade to enable inspection of painting. The final finished thickness of paint film shall not be less than 60 microns and shall not be more than 100 microns.

10.08 The finished paint appearance shall be aesthetically pleasing and shall be free from scratches, dents or unevenness. A small quantity of paint shall be supplied free of cost for minor touching up, if any that may be required at site.

10.09 In case the tenderer proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted along with offer/bid for purchaser's review and approval.

11.00 **WIRING:**

11.01 All wiring shall be of switch board type super flexible multi-stranded, tinned, annealed copper wire with suitable PVC insulation of 1.1KV grade conforming to IS-694 which has proved its utility in tropical regions against hot and moist climate and vermin (mice, white ants and cockroaches, etc.).

11.02 The size of wiring in different circuits shall not be less than those specified below:

Sl. No.	**Circuits**	**Area of cross-section of conductor (minimum permissible size of wire)**
1	Metering and relaying circuits connected to CTs and PTs	2.5 sq. mm
2	Audio visual annunciation, signaling and control circuits	2.5 sq. mm

3	AC/DC Auxiliary control supply circuits	2.5 sq. mm

11.03 Following colour scheme shall be used for the wiring.

Colour of the wire	**Circuit where used**	**Colour of the ferrule**
Red	Red phase of instrument transformer circuits	Red
Yellow	Yellow phase of instrument transformer circuits	Yellow
Blue	Blue phase of instrument transformer circuits	Blue
Green	Neutral connections earthed or not earthed in the instrument transformer circuits	Green
White	AC control wiring circuits using 415/ 240V auxiliary supply and cubicle lighting	Respective phase: Red, Yellow and blue Neutral : green
Grey	DC control wiring circuits	Red : Trip circuit Blue: indicating circuit Yellow: alarm circuit Green: relay, auxiliary and other interconnections
	Lower voltage DC supply (from DC-to-DC converter)	- “ -

11.04 All cubicle wiring shall be of the grouped type and laid out in flat formation on the framework, in the interior of the panel cubicles and secured to it by means of cleats. Wiring shall be run straight and given right angle bends wherever necessary. Wiring round the hinges shall be of extra flexible conductors twisted around the axis of the wires.

Longitudinal through extending throughout the full length of the panel shall be preferred for the intern panel wiring. Interconnection to adjacent panels shall be brought out to a separate set of terminal blocks located near the slot of holes meant for taking the interconnecting wires. All potential bus wiring, audible alarm, bus wiring, AC & DC control supply bus wiring, wiring for cubicle lighting and such other wiring which runs from cubicle to cubicle within the switchboard shall be laid down in gutters and shall be carefully screened.

Wiring connected to the space heaters in the cubicle shall have porcelain headed insulation over a safe length from the heater terminals.

Each wire shall be continuous from end to end and shall not have any joints within itself. Individual wires shall be connected only at the

connection terminal or studs of the terminal blocks, meters, relays, instruments and other switch board devices.

Terminal ends of the wires shall be provided with numbered self-locking ferrules suitably coloured for phase identification. At points of intersection where a change of number is necessary, duplicate ferrule shall be provided with the appropriate numbers on the changing end.

Wire ends shall be elegantly hooked with Ross - Courtney solder less Terminals. At the terminal connection, washers shall be interposed between wire terminals and the holding nuts. All holding nuts shall be secured with locking nuts. The connection stud shall project at least 3 mm from the lock nut surface,

Wiring shall be so connected at the terminal studs that no wire terminal number ferrule gets masked due to succeeding connections. All wire shall be suitable for bending and shall meet the terminal studs at right angles with the stud axis and they shall not be skewed.

All studs, nuts, bolts, screws etc., shall be threaded according to the IS practice unless purchaser's approval to any other practice of threading is obtained. Spare quantity of nuts, lock nuts and washers of all varieties used on the switchboard shall be supplied to the extent of 10% of the used quantities. The supplier should note that there would be no mezzanine floor for the control room building for cable spreading and the method of taking the cables directly into panel form the duct shall be clearly indicated.

Contractor shall be solely responsible for completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

12.00 TERMINAL BLOCKS AND TERMINAL CONNECTORS:

12.01 Terminal blocks shall be of the projecting stud type with check nuts and washers. The insulation housing of the terminal connector along with barriers shall be moulded form thermosetting resin dielectric and shall be of AC 1100V grade. The stubs shall be fully threaded and shall be of tin-plated brass. The size of the stubs shall be suitable for a continuous rating of not less than 35 Amps and shall accommodate the conductor terminal with a close fit, check nuts and washers shall also be of tin-plated brass. Check nuts shall be hexagonal and shall be suitable for being tightened with tubular box type spanners. The end termination facility shall be suitable for tightening with screwdriver. Tin plated brass inserts shall be provided between the terminal connector studs for effective resistance free, electrical contact between the incoming and outgoing terminations.

12.02 Terminal connectors shall be preferably of bolt and nut type for being assembled on to standard mounting channels for multi-way grouping to form terminal blocks. These terminal blocks shall be mounted

vertically in columns inside the panel in a pillar type formation and shall be so located that the incoming tail ends of the control cables can be terminated to these terminal blocks easily.

12.03 All terminal blocks shall be provided with removable shrouds made of transparent dielectric material rated for 1100V grade. Each shroud shall be etched or provided with a plastic marker strip to identify the circuits that are terminated.

12.04 Each terminal block shall be provided with at least 30% spare terminals on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

12.05 All stubs, nuts, screws etc., shall be threaded according to IS:7684. Sufficient spare quantities of all varieties and size of bolts, studs, nuts, washers and screws used in the cubicle shall be supplied along with cubicle free of cost.

12.06 Where terminal blocks are arranged in different columns or rows then minimum clearance of 150 mm shall be provided between the terminal block. A minimum clearance of 250 mm shall be kept between Terminal blocks and associated cable gland plates.

12.07 Terminal blocks containing CT secondary leads shall be provided with test, isolating, short circuiting facilities / sliding link type and VT's secondary leads shall be provided with isolating features.

12.08 Arrangement of terminal block assemblies and wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of terminal block opposite to wiring duct shall be reserved for the owner's external cable connections. All the adjacent terminal blocks shall also share the field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

13.00 SPACE FOR CONTROL CABLES AND CABLE GLANDS:

All control and supply cable will be connected at the bottom of the cubicles. The bottom plates of panels shall be fitted with removable gland plates and fixed with the cable glands, the size of which shall suit the owner's external cables. Cable glands shall be screened type and made of brass or nickel-plated steel and shall be suitable for PVC unarmoured cable. Necessary drawing showing the cable entry position and foundation bolt location shall be supplied by the bidder. The required quantities of cable glands suitable for the cable sizes as described below shall be provided in each panel.

19 C x 2.5 Sq. mm for Power Transformer.

19 C x 2.5 Sq. mm for Circuit Breaker.
10 C x 2.5 Sq. mm for Circuit Breaker.
4 C x 6.0 Sq. mm for CT Circuits.
2 C x 10 Sq. mm for NCT Circuits.
4 C x 10 Sq. mm for PT Circuits.
10 C x 2.5 Sq. mm for Isolator.
2 C x 2.5 Sq. mm. for coupling capacitor.

14.00 MIMIC DIAGRAM:

14.01 Each control panel shall be provided on the front face of the panel with a mimic bus of the system and of the circuit to which the panel refer-to. The width of the mimic bus shall not be less than 10 mm. The mimic bus shall represent the single line diagram of the system and indicate the relative position of each equipment in the run of the mimic bus. Corresponding control switches shall be mounted along the mimic diagram at appropriate location.

14.02 The mimic bus shall be of the anodized aluminum strip type with distinguished colours to differentiate between different voltages.

COLOUR SCHEME FOR MIMIC DIAGRAM:

Voltage class for new stations	Colour	Shade index as per IS 5
110KV	Dark brown	412
66KV	**Canary yellow**	**309**
33KV	Brilliant green	221
11KV	Signal red	537
415 V	Violet	796
Earth	Black	----

In case of extension panels, the colour of the mimic should match with the existing colour of the mimic, which will be furnished.

14.03 Mimic diagrams shall be incorporated with colour lamp indicators for indicating isolating switch position, circuit breakers status indication and also flash type lamp for auto trip shall be provided for the breaker.

15.00 NAME PLATE & MARKINGS

15.01 Each unit control and relay panel shall be provided with a circuit label of size 40mm x 200mm (min) located prominently at the top on the front and rear face of the duplex panel. Circuit labels shall be located inside the cubicle also for easy identification on both halves of the panel. These name plates and labels shall bear the name of the circuit or equipment etc., to which the panel is associated with. The letter shall have a minimum height of 20mm.

15.02 The name plate shall be 50mm width plates made of brass or black plastic and shall be etched with 3mm sized letters of the name of the associated circuit / equipment. The etched letters shall be duly filled in with white enamel paint, if the plate is of black plastic or with black enamel if the plate is of brass.

15.03 All instruments, relays and such other electrical devices and accessories mounted in the control panel shall be provided with name plate bearing the name of the manufacturer, serial number, type and technical rating data. These name plates shall be installed at the rear of the device inside the cubicle.

15.04 All instruments and control switches shall bear clear inscription identifying its function eg, BREAKER, AMMETER, etc., Similar inscription shall also be provided on each devices whose function is not otherwise identified. If any switch device does not bear this inscription, separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indicating eg. “Trip-Neutral-Close", "ON-OFF, "R-Y-B-OFF” etc. Where equipment has ASA code number such as for relays, CBs etc., the identity plate shall bear this number with appropriate prefixes and suffixes in addition to the function name. The ASA code numbers shall be the same as the one indicated by the bidder in the detailed wiring diagram.

15.05 Each panel shall be provided with a label located at the bottom corner on the front and shall contain the following details:

i. Manufacturer's name.
ii. P.O. No. & date.
iii. Drawings reference No. that pertains to that panel.
iv. Serial No. of the panel.

The letters on name plates shall have minimum height 4 mm and the gap between lines / words shall be more than 2 mm.

16.00 INTERNALLY MOUNTED EQUIPMENTS:

16.01 SPACE HEATERS:

Each control and relay panel shall be provided with a strip type or coil type tubular enclosed space heaters to prevent condensation of moisture within the panel. It shall be installed at the base of the cubicle and operated on 240V AC single phase supply. The surface temperature shall be well below visible heat. Space heaters shall be provided with an independent switch control, fuse and an adjustable thermostat to regulate the temperature.

16.02 PANEL LIGHTING:

The interior of the cubicles shall be illuminated by fluorescent lamps. The illumination shall be free from hard shadows and shall be planned

to avoid any strain or fatigue to a wire man working inside the cubicle due to any abnormal or non-uniform illumination. These lamps shall be operated through switches or door push buttons. It shall operate on 240V, AC single phase supply.

16.03 POWER SOCKETS:

At least 3 nos. of 5 Amps three pin multiple plug points and 2 nos. of 15 Amps, 3 pin power plug outlets shall be provided at convenient points in each set of the 66kV control panels. The plug points shall be provided with electrical and mechanical cover with chain. For simplex panels, a single phase 5A plug and socket and a 15 Amp. 3 Pin power plug & socket with switch is to be provided with security cover

17.0 FUSES:

17.01 H.R.C. fuses of adequate current and voltage rating shall be provided inside the cubicle for the various protection, control and incoming auxiliary AC & DC supply circuits.

The fuse bases and carriers shall be mounted inside the cubicle in an easily accessible location. They shall conform to relevant standard and shall be designed to carry HRC cartridge fuse links. The fuse bases and carriers shall be moulded from the thermosetting resin dielectric or moulded standard grades phonolic Bakelite or equivalent thereof and shall be black in colour. The selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. All accessible live connections to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carriers and bases shall have imprints of the fuse rating and voltages.

There shall be individual fuse units for each of the following circuits:

i) Signaling and Annunciation circuits.
ii) V.T. secondary instrument circuits.
iii) V.T. secondary, relay circuits.
iv) AC & DC control circuits (shall be separate for CB & Isolators).
v) AC auxiliary circuits.
vi) AC Power socket, cubicle space heater and lighting.
vii) Others if any.

18.00 EARTHING:

18.01 All panels shall be provided with a bare copper tinned earthing bus extended throughout the length of the panel. The size of the earthing bus shall not be less than 25 mm x 6 mm, when several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connection and clamps for this purpose shall be included in the scope of supply. Provision shall be made for extending the earth bus bars at a future date into new adjacent panels to be

installed if any. Provision shall be made at the end panels for connecting the same to the system earth ground mat.

18.02 All metallic cases of instruments, relays, accessories installed within the cubicle shall be connected to the earth bus with 1100V grade standard multicore 2.5 sq. mm PVC insulated conductor of green colour. The run of the wires shall be continuous without any joints and shall be crimped at either end with open type solder less lugs.

18.03 Looping of earth connections, which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

18.04 VT & CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

19.00 INDICATING LAMPS:

19.01 Indicating lamps shall be integral LED module type, 0.7 watts suitable for 110V DC supply / 240V AC for DC fail indication, as the case may be and these shall be integral, self-contained LED indicator units which can be directly mounted on the panel. The rated input voltage can be directly applied to module input, as all the controlling circuitry is built in to the module body itself. These modules shall be suitable for panel, cutouts of size 22.5mm dia with the use of chrome plated standard mounting bezel/ adopter sets. The axial light intensity should be minimum 40milli candela.

19.02 LED lamps shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the LED lamps shall also be included in the scope of supply.

19.3 The indicating lamps shall withstand 120% of rated voltage on a continuous basis.

19.4 The colour scheme of the signal lamps shall be as follows:

Signal for	Indicating by light
CB closed	Red
CB open	Green
CB auto trip	Amber*
Isolator closed	Red
Isolator open	Green
CB spring charging indication	Blue
PT phases / trip circuit supervision	White

* CB - Auto trip and to indicate abnormal conditions requiring action such as discrepancy in operation of protection circuits of alarm circuits.

19.05 In the initial supply, 25% of the lamps actually used on the switch board shall be supplied in excess to serve as spares.

20.00 TEST TERMINAL BLOCKS:

20.01 Each control panel where metering is involved shall be installed with instrument test terminal blocks. These test terminal blocks shall be designed for use on panels with poly-phase meters to facilitate their in-situ testing. The test terminal blocks shall be mounted at the bottom end of the front face of the panel. They shall be of the projecting type semi-flush mounted with wire connected at the back. All wiring to indicating, integrating and recording instruments shall be done through the Test Terminal Block. The test terminal block shall be provided with screw type front cover such that the removal of this cover shall grant access to the terminals in the front for connecting check meters or for injection of external supply to the panel instruments.

20.02 The test terminal blocks shall facilitate in-situ testing of instruments without interrupting the primary load circuit. The current terminals shall therefore be provided with shorting arrangement through links before interrupting the normal circuit for insertion of external check meters or for injection of an external supply into the panel instruments without causing an open circuit in the current transformer secondary. The potential terminal shall be provided with sliding links for isolation of the normal supply voltage to the panel instruments from the secondary of voltage transformer.

20.03 The test terminal block shall have its insulation housing made of a moulded dielectric material such as phonolic Bakelite or equivalent thereof with adequate insulation between current and potential terminals of different phases. The potential testing studs shall preferably be housed in narrow recesses of the block moulded insulation to prevent accidental short circuit between potential studs themselves or between potential and current terminals. The cover studs to be provided shall be suitable for sealing with lead seals so as to prevent unauthorized access to the test studs.

20.04 The test terminal block rating shall be 1100 volts, 35 Amps, The terminals shall be nickel-plated brass and their contact resistance shall be less than 1 milli ohm. The test Terminal Block shall preferably be of IMP make or any other standard link type makes.

21.00 CONTROL SWITCHES:

21.01 Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out. Handles of different shapes and suitable inscriptions on switches shall be provided as an aid to switch identification.

21.02 The selection of operating handles for the different types of switches shall be as follows;

a) Breaker, isolator control switches	Pistol grip, black
b) Synchronizing switches	Oval, black, keyed handles (one common removable handle for a group of synchronizing switches or locking facility having common key)
c) Selector switches	Oval or knob, black
d) Instrument switches	Round, knurled, black
e) Trip transfer switches	Pistol grip, lockable, black

21.03 The control switch of breaker and isolator shall be of spring return to neutral type. The spring return type shall be provided, with lost motion device and minimum ten ways for CB control switch and four ways of isolator control switch. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. The spring return type switch shall have spring return from close and trip positions to “after close" and "after trip" position respectively.

21.04 Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selection switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line-to-line and line-to-neutral voltages for non-effectively earthed systems and for reading all line to line voltages for effectively earthed system.

21.05 Lockable type of switches, which can be locked in particular positions, shall be provided when specified. The key locks shall be fitted on the operating handles.

21.06 All control switches wires shall be connected at the back. The contact mechanism shall become operated. The contacts shall be silver plated and designed for liberal rating of the duty involved. The contacts shall be provided with a dust and vermin proof removable protection cover. The protection cover shall preferably be of transparent, inflammable material made of moulded dielectric materials. Springs to be provided in the switch shall not be used as current carrying parts.

The contacts provided in the switch shall not be used as continuous current carrying parts.

The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme. The contact rating of the switches shall be as follows :

Description	Contact rating in Amps	
	110V DC	240V AC
a) Make and carry continuously	10	10
b) Make and carry for 0.5 seconds	30	30
c) Break: 1. resistive load 2. inductive load with L/R = 40 ms	 3 0.2	 7 ---

21.07 The isolator shall have electrical interlock, so that isolator can't be opened or closed if the CB is in closed position, if any attempt is made there shall be an audible and visual alarm.

22.00 Void

23.00 PUSH BUTTON SWITCHES

a) Push button switches provided, shall be of the momentary contact type wired back connected. They shall be semi-flush mounted and where required they shall be shrouded to prevent inadvertent or undesirable operation. They shall be provided with integral inscription plates engraved with their functions.

b) All push buttons shall be with two sets of Normally Open (NO) and Normally Closed (NC) contacts. The contact faces shall be silver plated and shall be able to make/break and carry the rated current. The rated current shall be appropriate to the duty of the desired function, but not less than 5 Amps.

24.00 Void

25.00 ANNUNCIATION SYSTEM:

25.01 Separate Alarm annunciation system shall be provided for each control panel by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltage specified.

25.02 The annunciation shall be of visual and audible type. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels. The audible alarm shall be provided by alarm buzzer or bell.

25.03 The annunciator facia shall be provided with translucent plastic window for alarm point with minimum size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions,

which will be approved by the purchaser. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5mm. At the existing sub-station's control rooms, annunciation scheme shall be engineered as an extension to the existing scheme.

25.04 Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The lamp circuit shall include series resistor of adequate rating. The cover plate of the facia windows shall be flush with the panel and shall be capable of easy removal to facilitate replacement of lamps. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity (500 Lux), from the location of the Operator's desk.

25.05 TRIP & NON-TRIP facia shall be differentiated. All TRIP facia shall have red colour and all NON-TRIP facia shall have white colour.

25.06 Sequence of operation of the annunciator shall be as follows:

Sl. No.	Alarm condition	Fault contact	Visual annunciation	Audible annunciation
1	Normal	Open	OFF	OFF
2	Abnormal	Close	Flashing	ON
3	Accept push button is pressed	a) close b) open	Steady ON Steady ON	OFF OFF
4	Reset push button is pressed	a) close b) open	ON OFF	OFF OFF
5	Lamp test push button is pressed	Open	Steady ON	OFF

25.07 Visual and audible annunciation for the failure of DC supply to the annunciation system shall also be provided and this annunciation shall operate on 240V AC supply with separate fuses. On failure of the power supply to the annunciation system for more than 2 or 3 secs (adjustable setting) a facia shall light up and a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to the annunciation system is restored. The sound of the audible alarm (bell) provided for this annunciation shall be different from the audible alarm provided for the annunciation system.

25.08 A separate voltage check relay shall be provided to monitor the failure of supply (240V AC) to the scheme mentioned in the above Clause. If the failure of supply exists for more than 2 to 3 sees, this relay shall initiate visual and audible annunciation.

The annunciation system described above shall meet the following additional requirements:

a) The annunciation system shall be capable of catering to at least 24 simultaneous signals at a time.

b) One self-resetting push button shall be provided on each panel for testing the facia window lamps. Push buttons for testing flasher and audible alarm circuit of annunciation system and for testing the annunciation supply failure monitoring circuit shall be provided. These testing circuits shall be so connected that while test is being done it shall not prevent the registering of any new annunciation that may land during the test.

c) One set each of the following push buttons shall be provided on each panel.

i) Reset push button for annunciation system.

ii) Accept push button for annunciation system,

d) The annunciation shall be repetitive type and shall be capable of registering the fleeting signal. Minimum duration of the fleeting signal registered by the system shall be 5 millisecs.

e) Auxiliary relay for annunciation system shall have adequate auxiliary potential free contacts for use in event logger.

f) The annunciation shall be suitable for an operation with normally open fault contacts. Which close on a fault. For fault contacts which open on a fault, it shall be possible at site to change annunciators from "close to fault" to "open to fault" and vice versa.

g) The annunciation relays shall be electro-magnetic type and should not get affected by spurious external signals and should give long trouble free service in hostile atmosphere encountered in sub-stations like switching of EHV breaker, Isolator etc.

h) The annunciation system to be supplied for the existing substations have to be matched with the existing scheme in coordination with the purchaser during detail engineering stage.

25.09 One set of bell, hooter shall be provided for each group of 66 kV line / transformer panels. Each of these sets of bell and hooter can be provided in any one of the line/bus coupler panel of respective groups. The bell and buzzer shall have clear resounding ringing tone audible at the far end of the control room or the station. Suitable hand reset relay devices shall be provided for the bell and buzzer circuits to allow for manual cancellation of the audible alarm in token of its acceptance by an operator before rectification of the abnormality can be made. The wiring shall be such that one set of bell and alarm cancellation relay shall be sufficient and serve in common with all the associated alarm actuating devices caused by tripping of the equipment/ breakers, for each group of 66kV line / transformer panel. Similarly there shall be one set of buzzer and alarm cancellation relay or each group to serve in common with all the alarm actuating devices which do not cause tripping of the equipment/breakers for each group of66kVline / transformer panel.

21.10 The number of facia windows required is indicated in the schedule of annunciator windows in Annexure. The facia details of windows to be connected to trip circuitry and non-trip circuitry will be furnished to the successful bidder.

26.00 INDICATING & INTEGRATING INSTRUMENTS:

26.01 GENERAL REQUIREMENTS:

a) All indicating and integrating instruments shall be of the switchboard type, wired back connected and semi flush mounted, with only the instrument bezels projecting on the front face.

b) The instrument dials shall be fully tropicalised and shall be of such materials as to ensure freedom from warping, fading or discoloration. All scale markings shall be in black on white instrument dial background. Knife edge pointers and parallax free dials are preferred.

c) All instruments shall be provided with dust tight cases. All nuts, screws and threaded parts shall preferably conform to relevant standards and all indicating instruments to IS - 1248 or relevant standards.

d) The indicating instruments shall have an accuracy class 1.0 or better. The design of the scales shall be such as to have a resolution corresponding to 50% of the accuracy class index. The integrating instruments shall have an accuracy class 0.2 or better.

e) All indicating instruments shall be provided with a front of board zero pointer adjuster capable of being operated safely even when the instrument is in service. The adjustment above and below the zero point shall not be less than 3% and not more than 6% of the full scale reading. The adjuster shall be capable of being rotated through an angle of 360 degree without damage to any part of the instrument and it shall have sufficient friction or spring control to keep the adjustment in position.

f) All the indicating instruments shall be in conformity with relevant standards. The bidder should note that the instrument security factor of metering CT's is 5 and hence all the meters should withstand 5 times the normal secondary current without any damage.

g) All circuits of the instruments shall be capable of withstanding applied load of 20% greater than the rated capacity for period of eight hours.

h) All current and/or voltage coils of meter shall withstand continuously 120% of the rated current/ voltage and 200% thereof for 0.5 seconds without loss of accuracy.

i) All indicating instruments shall be provided with direct reading double range scales. The scale ranges are indicated in the panel wise schedule

of requirements. The ammeter and voltmeter scale ranges are to be zero end suppressed.

j) Wattmeters, VARmeters, watthour meters and VARhour meters shall be of the 3 phase, 2 element type suitable for measurement of unbalanced loads in 3 phase circuits. The wattmeter and VARmeter scales shall be uniformly graduated with center zero unless specified otherwise to duly indicate Import / Export.

k) Watthour meters, VARhour meters and frequency meters shall be of static type. They shall record and indicate the measured parameters even at low voltage up to –30% of rated operating AC voltages and –20% of auxiliary supply voltages.

26.02 AMMETERS:

AC ammeters shall be moving-iron type 96 sq. mm, zero end suppressed, 240 degrees scale with dual range. It shall be suitable for 1 Amp (one Amp) CT secondary and for flush mounting.

26.03 VOLTMETERS:

AC voltmeters shall be moving-iron type, 96 sq. mm, zero end suppressed, 240 degrees scale. It shall be suitable for 110 V phase to phase VT secondary and for flush mounting.

26.4 MW/MVAR METERS:

MW / MVAR meters shall be of dynamometer type : three wire, 2 elements, 3 phase, 96 sq. mm, flush mounted type. It shall be suitable for 1 Amp CT secondary and 110 volts phase to phase VT secondary. All MVAR meters and MW meters of line panels shall be of centre zero type.

26.5 INTEGRATING METERS:

a) It shall of static type, 3 phase, 4 wire trivector meter suitable for 1 Amp, CT and 110 volts phase to phase VT secondaries. It must be flush mounted type and tropicalisesd. It shall have separate registers for recording kWh and kVARh consumption separately and also demands with automatic resetting at the end of the month and also to record EXPORT AND IMPORTS.

b) The meter should be of 0.2 accuracy class.

c) The meters shall have legible LED/LCD minimum 6 digits auto-cycle display. The meter shall have non-volatile memory requiring no battery back up.

d) The meter shall conform to detail specification enclosed as in ANNEXURE.

26.06 FREQUENCY METER:

Frequency meter shall be of static type. It shall indicate frequency up to second decimal point, it shall operate from 110V, AC bus VT secondaries. It shall be flush mounted type and tropicalised.

26.07 TRANSDUCERS:

Transducer (for Telemetry/Data Communication application) shall in general conform to IEC: 688-1 and have the following features:-

a. The Transducers shall be suitable for measurement of active Power, reactive Power, Voltage, Current and frequency in three phase four wire unbalanced system.

b. The input to the transducers will be from sub-station current & potential transformers. The output shall be in milli ampere D.C proportional to the input and it shall be possible to feed the output current directly to the telemetry terminals or indicating instruments or recording instrument.

c. The transducer characteristics shall be linear throughout the measuring range.

d. The transducer output shall be load independent.

e. The input & output of the transducer shall be galvanically isolated.

f. Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs. Input side terminal connectors (from CT & PT) to be suitable for 3 phase, 4 wire connection.

g. The transducers shall be suitably protected against transient high peaks of voltage and current.

h. The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.

i. The voltage, frequency & current transducers shall have an output of 4-20mA.

j. The response time of the transducers shall be less than 1 second.

k. The transducers shall have a working temperature range of 0-50 degree C.

l. The accuracy class of transducers shall be 1.0 or better for voltage/current transducer, 0.5 or better for W/VAR transducer and 0.2 or better for frequency transducer.

m. The transducers shall have a low AC ripple on output of less than 1%.

n. The transducers shall be suitable for load resistance of 1000-1500 ohms.

o. The PT ratios and scale ranges for the voltage & frequency transducers shall be as follows:

Voltage transducers:	60kV/110V	0-90KV
Frequency transducers:	-Do-	45-55Hz.

The current, active & reactive power transducers shall be suitable for the various CT & PT ratios (as applicable) furnished with the specification and compatible with the feeder/transformer voltage levels & ratings.

p. The transducer shall be provided with terminal connectors for wire of maximum cross section of 4/6sq.mm. with dual screws, for rigid connections.

q. The transducer shall have dual output.

27.00 RELAYS:

27.01 GENERAL EQUIPMENTS:

a) All relays shall conform to requirements of IS 3231/IEC 50255/ IEC 6100 or other applicable standards. Relay shall be suitable for flush or semi-flush mounting on the front with connection from the rear.

b) All main protective relay shall be Numerical type.

c) A detailed note regarding the various quality control procedures adopted by the manufacturer should be given with special reference to numerical relay components on their quality assurance tests. Information should be furnished regarding various equipment used for quality assurance tests.

d) The numerical relays offered must have proven performance. The bidder shall give a detailed account of the field experience of the relays offered, information regarding experience in designing etc.

e) The protection scheme at the other end of the transmission line will be furnished to the successful bidder if required. The other

particulars like distance of the lines, impedance, CT ratios, PT details will be furnished to the successful bidder and should provide the protection schemes suitable for parameters furnished.

f) The relay codes mentioned in the wiring/ schematic diagram, for auxiliary relays etc., which are part of a composite relay, shall be marked on the name plate provided. This is required to facilitate the field staff, to identify the auxiliary relay provided in the composite unit at the time of trouble shooting.

g) All relays, other components, wiring etc shall withstand a test voltage of 2.5kV RMS, AC, 50 Hz.

h) The tenderer shall give a detailed account of the field experience of the relays offered. Information regarding experience within the country should be indicated, giving the approximate quantity of similar relays supplied in India. The bidder should also give an account of his experience in designing coordinating similar protective gear within the country.

i) The tenderer shall indicate what facilities are available with him within the country for repair / recalibration of the relays offered by him. Whether such facilities are available for the repair of imported relays included in his offer shall also be stated in the tender.

j) The tenderer shall indicate what facilities are available with him for commissioning these Relays. Such facilities shall cover indigenous and imported equipment. The bidder shall arrange to train at his cost the engineering staff of BWSSB for trouble- free operation and maintenance of these relays.

27.02 a) The protective and auxiliary relays offered shall be of proven design and based on sound principles and should conform to BS: 142 and IS: 3231 and IEC: 255 wherever applicable. The protection equipment shall be designed and applied to provide maximum discrimination between faulty and healthy circuits and its performance shall be in accordance with the BS standard 3950. The equipment shall remain in operation during transient phenomenon, which may arise during switching or other disturbances to the system. They shall be in standard cases and shall be provided with dust and vermin proof cases and covers, the covers shall be transparent and shall be removable from the front. The relay shall be suitable for semi-flush mounting only the flanges projecting in the front and with connection from the rear. The relays shall be rectangular in space and dull black or egg shell black enamel painted cases.

b) All protective relays shall be in draw-out or plug-in type / modular cases with proper testing facilities. The testing facilities

provided on the relays shall be specifically stated in the tender. Necessary test plugs shall be supplied loose and shall be included in bidder's scope of supply. Test block and switches shall be located immediately below each relay for testing. As an alternative to test block and test plug arrangements the bidder shall also quote alternative testing facility of protective relays by providing a push button which when pressed connects the testing equipment to the relay coils and injects current in the coil and automatically disconnects the trip circuits and on operation of relay gives a signal that the equipment and the circuits are correct. The above tests shall be carried out without short circuiting the CT secondary connections. The Purchaser reserves the right for accepting any one of the above two testing facilities. Unless otherwise specified all auxiliary relays and timers shall be supplied in non-draw out cases/ plug-in type modular cases.

c) All AC relays shall be suitable for operation at 50 Hz AC Voltage operated relays shall be suitable for 110 Volts VT secondaries and current operated relays for 1 Amp CT secondaries as specified. DC auxiliary relays and timers shall be designed for the DC voltage specified and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

d) All relays coils requiring a continuous voltage shall have adequate thermal capacity for continuous operation. The current and voltage coil shall be rated for the current and voltage rating specified under system details and auxiliary supply.

e) The power supply unit shall be fully rated with liberal design in capacity.

f) The DC supply for solid state relay shall be from DC / DC converters and these shall be amply and fully rated for all operating conditions in service. Provision of DC stand by power supply will however not be acceptable.

g) The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts/ suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. and also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme, contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts. Relay cases

size shall be so chosen as not to introduce any limitations on the use of available contacts on the relay due to inadequacy of terminals. Paralleling of contacts, if any shall be done at the terminals on the casing of the relay.

h) All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription subject to purchaser's approval. All protective relays which do not have built in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this purpose. Similar separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as Buchholz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.

i) There shall be no relay in the protective circuits, which shall cause tripping of the circuit breaker when the relay is de-energized.

j) Timers shall be of the electromagnetic or static type. Pneumatic timers are not acceptable. Time delay in term of millisecs obtained by the external capacitor/resistor combination is not preferred and shall be avoided.

k) Provision shall be made for easy isolation of trip circuit of each relay for the purpose of testing and maintenance.

l) All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for further use.

m) The setting range of relays offered, if different from ones specified shall also be acceptable if they meet the functional requirement.

n) Any alternative/ additional protection of relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with BWSSB.

o) Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured.

   i) The operating time of the series seal-in-units shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

ii) Seal-in-units shall obtain adequate current for operation when one or more relays operate simultaneously.

iii) Impedance of the seal-in-units shall be small enough to permit satisfactory operation of the trip coil on trip relays when D.C supply voltage is minimum.

iv) Trip-Circuit seal-in is required for all trip outputs irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip outputs but also the relevant initiation signals to other scheme functions (e.g.initate signals to the circuit breaker failure function, reclosing function etc.,) and the alarm output signals.

v) Two methods of seal –in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).

vi) For the current seal-in method, the seal-in shall be maintained until the circuit breaker opens, at which time the seal-in-shall reset and the seal in-method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single-and three-pole tripping.

vii) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping Trip-circuit seal-in shall not take place under sub-harmonic conditions.

p) For numerical relays the scope shall include the following:

Necessary software & hardware shall be provided to up/download the data to/from the relay from/to the personal computer provided in the station.

The relay shall have suitable communication facility for connectivity to sub-station system/SCADA.The relay shall be capable of supporting open protocol IEC 870-5-103.

27.03 a) The materials, the components of static / numerical relays shall be designed to withstand the most severe tropical climatic conditions such as corrosive atmosphere, saline, fog, damp, heat and fungus prone environment. These devices as such shall be tropicalised in such a manner so as to meet with the IEC-68 standard.

b) The components shall be loaded by less than half of their rated values. The resistor shall be of carbon composition or metal oxide type and the capacitors shall be plastic film or tantalum

type. Stringent measures including shielding of long internal wiring should be taken to make relays immune to voltage spikes. As per IEC, the relays must meet the requirements of IEC-255-4, appendix 'E'. Class-III regarding HF disturbance tests, IEC-255-4 regarding impulse test at 5kV and fast transient test as per IEC-801-4. Insulation barriers shall be provided to ensure that transients present in CT & VT connections due to extraneous source do not cause damage to circuits.

c) The. cases, racks and sub-units shall preferably be of stainless steel. The screws used in cases, racks and sub-units shall be either of stainless steel or zinc plated steel.

d) The material of connector terminal blocks shall be of dielectric moulded type resin. The connector plugs shall be corrosion resistive and the lugs shall be made of tinned brass with the contact face silver / gold plated. All connections with the connector plug shall be by wire wrapping.

e) The static/ numerical components forming the electronic solid state circuitry shall be mounted on printed circuit board of adequate thickness and made of stratified glass epoxid. A protective lacquer shall be applied when all the components are soldered. Transformers in the circuitry shall also be impregnated with the same lacquer. All components shall be clearly marked and all wiring colour coded and tagged. Flat ribbon cable is exempted from being tagged.

f) The electromechanical relay contacts shall be protected with non-inflammable plastic covers.

g) The relays shall be modular units assembled in fully tropicalised draw out cases with the modules or sub-units plugged into racks. They shall be electrically isolated on the measuring side through intensity or voltage input transformers with shield bonded (at the over voltage/fixed voltage) and on the operation side through on/off relays. The layout of measurement inputs, output relays, detection circuits and visual display such as to eliminate mutual interference of the circuits involved. Internal test points shall be provided on the printed circuit at typical points of the relay diagram. These test points, if possible shall be provided on the front of the relay to enable testing during operation without having to disconnect the relay.

h) Insulation barriers shall be provided to ensure that transients present for CT and VT connections due to extraneous sources do not cause damage to circuits. The Numerical relays offered shall be tested to withstand both 5 kV impulse tests and high frequency disturbance stipulated by IEC. Details of the equipment used for tests shall be furnished.

i) The relay shall be designed for designed for shock wave resistance, temperature resistance, humidity resistance, transportation resistance and storage resistance and to be insensitive to radio frequency interferences.

j) The performance of static/numerical relay shall not be affected by transient, common mode and transient mode electromagnetic interference.

k) The solid state relays shall be stable and suitably protected against transient/ induced over voltages and noise signals. The bidder shall state clearly in his bid, special requirements, if any, for DC input arrangement or cabling considered necessary for satisfactory operation of solid state relays quoted by him.

28.00 **PROTECTION SCHEME:**

28.01 Protection scheme shall consist of following :

a) The main protection, distance and differential protection relays are required to protect the 66kV lines and 66/6.6kV Power Transformers and clear the fault within shortest possible time with reliability, selectivity and full sensitivity to all type of faults. The relay shall be fast acting numerical type.

b) Back up protection shall be of Electromagnetic type.

28.02 A) Void
B)
C)
D) VOID

28.03 Numerical Distance protection scheme for 66kV Lines:

Numerical distance protection shall be suitable for use with permissive under reach and overreach required. Relay shall have continuous self-monitoring and diagnostic feature.

The detailed description of protection is given here under.

The numerical distance protection shall:

i. Be suitable for one amp CT secondary and 110/√3V AC Potential from potential transformer of 66 kV Bus.

ii. Be Numerical and modular in construction.

iii. Have high speed switched distance relay for three phase systems to clear all type of line faults within the set reach of the relay, under all operating conditions.

iv. It should cover at least two line sections completely with 25% additional margin.

v. Measure all type of faults by switching over to the measuring elements. The reach of each zone shall be independently and individually adjustable over wide range in suitable steps of 1%. Memory circuits with defined characteristics shall be provided in all three phases to ensure correct operation during close-up 3 phase faults and other adverse conditions.

vi. The protection scheme shall be fast and first zone shall energize the circuit breaker trip coil in about one and half cycle. The tripping time of the second and third zone should be adjustable to any desired value through a separate timing unit.

vii. Have stepped time distance characteristics and shall have at least two directional and one non-directional independently variable time graded distance protection zones to cover two adjacent line sections.

viii. (a) Three zones and one reverse zone of operation shall be available. The reach of the relay for zones 1, 2 & 3 should be able to cover line lengths as per clause (iv) above. The relay shall have an adjustable characteristics angle setting range of 30-75 degree.

(b) Be field selectable for various over reaching, under reaching setting and blocking/ inter tripping communication scheme.

(c) Have mho/rectangular/polygonal/circular/oval/lens/quadrilateral characteristics with a facility to set resistance and reactance independently to cater for arc resistance on short lines and load discrimination for long lines.

ix. Ensure that this long coverage is consistent with limitations imposed by heavy loading and sound phase component of fault current.

x. The scheme shall not become inoperative even under severe system fault condition near the location of the relay when the potentials applied to the relay are very small. If characteristics of starting relays are such that it cannot pick-up because of very low infeed, under voltage relays may also be used as supplementary relays.

xi Have facilities for offset features with adjustable 10-20% of zone -3 setting.

xii. Have residual compensation variable up to 150%.

xiii. Operate instantaneously when circuit breaker is closed to zero volt 3 phase fault.

xiv Have a continuous current rating of two times the rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall also be capable of carrying a high short time current of 70 times rated current without damage for a period of 1 sec.

xv Be selective between internal and external faults.

xvi Include fuse failure protection which shall:

al) Monitor all the three fuses of VT circuit, and associated cable against open circuit.
a2) Inhibit trip circuits on operation and initiate annunciation.
a3) Have an operating time less than 7 milliseconds.
a4) Remain inoperative for system earth faults.
a5) Be of solid state type.

xvii. Have facility for under voltage and over voltage protection.

xviii. Have self-diagnostic feature.

xix. Have facility for current & voltage circuit supervision.

xx. Suitable number of potential free contacts (if required, multiplied through reed relays only) be provided, on each distance scheme.

xxi. **Void.**

xxii. A separate out of step or power swing blocking relay shall be included to prevent tripping of the breaker during power swings and system disturbances. The breaker shall however be caused to trip if the disturbance lasts for an interval of time equal to or greater than the third zone time setting.

Nevertheless the impedance loci of the distance relays shall be such that they have minimum tendency to operate on power swings caused by system disturbance.

xxiii. The relay shall have the following features either built-in or separately.
a) Weakend in feed.
b) Power swing blocking.
c) Broken conductor detection.
d)Fault locator.

Fault Locators:

The fault locator shall be based on the impedance measurement of the line and shall be microprocessor based only. It shall be capable of measuring the location of the fault from the relaying point with an accuracy of 3% or better, for all types of faults including broken conductor detection. It shall be ON LINE type. The fault locator shall measure the measuring signals prior to the fault, during fault, before

tripping of the breaker and store them in the memory and process them at later stages. The accuracy of the measurement shall not be affected / influenced by line loading prior to the fault, remote in feed, magnitude of the fault resistance or mutual effect of parallel line(s), CVT transients, DC component of in fault current, heavy load conditions, temperature variations, frequency divisions. The fault locator shall have built in display unit for showing fault location, faulty phase(s), current and voltage magnitudes and their phase relationships. The fault locator shall be capable of being combined with the respective distance protection for phase selection information. The calculation of line protection shall take place when any of the line protections operate on fault. The calculation by the fault locator shall be based on measuring values prior to and during the fault. These data shall be stored in the memory of fault locator and calculation shall be made after tripping of the line breakers. The distance to fault shall be shown as % of line length or actual fault location in KM. The fault locator shall be suitable for its application with three (3) cycle circuit breaker. Fault locator shall have facilities to provide remote indication at central load dispatch / management centre via communication channels, which will be provided in near future. printer/display unit may be common for all the lines in each station. The fault locator shall be provided with additional contacts for starting printer and signaling for faults inside the fault locator.

NOTE: Provision of optional features other than those indicated above may be indicated separately. Provision may be made in the relay for updating these optional features at a later date whenever required by BWSSB.

28.04. Protection scheme for 66/6.6kV Power Transformer Numerical Differential Protection.

A) Numerical Differential Relay

a) It shall consist of fully numerical type, variable percentage, biased type differential relay. It shall be triple pole type, with faulty phase identification/ indication.

b) The percentage bias shall be low near rated current, sufficient to allow for OLTC tap variation and CT errors, but shall increase automatically for severe through faults to ensure stability even under CT saturation errors. It shall offer low burden to CTs.

c) The relays shall be suitable for rated current of 1 Amp and have three instantaneous high set over current units.

d) The relay shall remain stable under initial magnetizing inrush current, sympathetic inrush when adjacent transformers are charged, through fault stability and over fluxing conditions. The relay shall have second harmonic restraint feature.

e) The relay shall be very fast in operation with an operating time not greater than 30 milli seconds at 5 times setting.

f) The relay shall be accompanied by interposing auxiliary current transformers for angle and ratio correction or have internal features in the relay to take care of angle and ratio corrections.

g) The bias setting of the relay shall be adjustable with range of 20 – 50 %.

B) Restricted Earth fault Protection:

The restricted earth fault protection shall

a) Be single pole Numerical type.

b) Be of high speed, instantaneous current operated and high impedance type.

c) Have a current setting range of 10-40% of 1 Amp.

d) Be tuned to the system frequency. It shall have high rejection of DC component of fault current.

e) Have suitable non-linear resistor to limit the peak voltage to 1000 volts.

C) Over fluxing protections:

Void

D) Auxiliary relay:

The transformer protection panel shall be wired for buchholz alarm and trip, oil temperature alarm and low oil level. The auxiliary flag relays shall be provided for contact multiplication wherever they are needed for buchholz alarm/trip, winding temperature alarm/trip, oil temperature alarm/trip, pressure relief device trip, oil surge relay trip. Current operated relays shall be preferred to voltage operated relays.

28.05 BACK UP PROTECTION:

A) Over current/ earth fault relay:

i. Electromagnetic relay shall be provided as backup relays.

ii. The relay shall be single pole directional/non-directional IDMT relay with a definite minimum time of 3 seconds at 10 times setting. In case of directional relay the directional elements shall be voltage polarized. The maximum torque angle shall be 45 degree.

iii. All over current/earth fault relay provided in transformer panels shall be provided with high set instantaneous elements. It shall be adjustable insteps of 500% to 2000% and 200-800% or 100-400%.

iv. The current setting range of OCR shall be selectable from 50 to 200% and that of EFR shall be either 10-40%.

V. The operating coil of the DEFR shall be connected in the residual circuit of the star connection of the line CT's. The polarizing voltage for DEFR shall be obtained from the open delta connection of the VT secondary circuit.

vi. The backup protection as aforesaid shall operate independently of the main protection distance relay, to provide protection for the line section, in the event of failure of the distance relays, to clear the faulty section or failure of the main protection scheme relay.

vii. It should be possible to convert the directional relays to non-directional type by suitable means.

28.06 Void.

28.07 Void.

28.08 Tripping Relay:

Each panel shall be provided with high speed DC operated tripping relay. The relay shall have adequate number of normally open and normally close hand reset contacts to meet the requirement of scheme, other functions like auto re-closing relay, LBB relay, fault locator wherever applicable. The maximum operating time of the relay shall not exceed ten milliseconds and reset within 20 milliseconds.

28.09 Tripping Circuit Supervision Relay.

a) Each trip coil of circuit breaker shall be provided with an independent trip circuit supervision relay. These relays shall be mounted in the control panel associated with the circuit breakers. 66KV CB, there will be only 2 nos. of trip coils for all the three poles of CB.

b) These relays shall monitor the whole of the trip circuit while the breaker is in open or closed position and give an alarm for the loss of battery supply or for faults in the trip coil or for faults in the trip circuit such as leads, auxiliary contacts. The relay shall have a time delay on drop off of not less than 200 milliseconds and be provided with operation indication.

c) Trip supervision relay shall be located in the control panel.

d) The relay shall have adequate contacts for providing connection to alarm and event logger.

28.10 DC Supply monitoring relay:

The relay shall be capable of monitoring the failure of DC supply to which it is connected. Separate DC supply monitoring relay shall be provided for DC main circuit, control circuit of tripping relay and protection circuit of each panel. It shall have adequate potential free contact to meet the scheme requirement. The relay shall have a time delay on drop off of not less than 100msecs and be provided with operation indicator/flag. Indicating lamp and separate alarm for DC fail shall be provided and shall be operated by 230V AC single phase supply. Push buttons for test and accept shall be provided.

28.11 Void.

27.12 INTERLOCKING:

The control circuits for operation of the disconnecting switches in the line shall be so designed that the following interlocking features are provided for usual conditions of operation and all the necessary devices, auxiliary relays shall be included in the supply of control panels.

The other interlocks required are (a) it should not be possible to operate either of the bus selector isolators unless the other bus selector isolator, bypass isolator and line breaker is in de-energized condition. (b) it should not be possible to operate the by-pass isolator when the main breaker and the breaker disconnect isolators (on either side of the breaker) all are in closed position. (c) during change over from the line breaker to bus coupler control, both breakers will be closed and it will be necessary to close both the bus selector isolators for making the change over. The interlock required is that it should not be possible to operate either of the bus selector isolators when the line is in service, unless the bus coupler is also closed. (d) If the earth switch of the line isolator is connected to ground, it shall not be possible to close the bus isolator, by-pass isolator or the line isolator or the breaker.

28.13 Void**.**

29.00 PROTECTION PHILOSOPHY:

A) Void.

B) 66 kV LINE PROTECTION

Numerical distance scheme as principal protection and directional over current / directional earth fault electromagnetic relays as back-up

protection. The back-up protection shall operate independent of primary protection.

The voltage source for protection and meter circuits of the line feeder will be from the bus VTs.

For 66 kV sub-stations:

The voltage source for protection and metering circuits of the line feeder will be from Bus V.T's

C) Power Transformer Protection:

The protection scheme should trip the circuit breaker on HV and MV/ LV side of transformer for any fault in the transformer.

a) The differential protection scheme and REF as principle protection.

b) The directional electromagnetic OCR / EFR provided on HV side and DOCR/DEFR provided on MV/LV side shall act as back up protection.

c) The trip impulses received from Buchholz relay, winding temperature relay, pressure relief device, oil surge relay etc., provided by the transformer manufacturer, shall trip the breaker through an auxiliary relay.

e) The necessary matching transformers required for the protection scheme shall be supplied by the bidder and is deemed to be part of differential protection.

f) The back up protection shall operate independent of primary protection.

D) Bus Bar Protection: Void.

30.00 Co-ordination of Drawings of associated equipments of other manufacturers:

1. The purchaser intends to procure all outdoor equipments associated with these control and relay panels from other manufacturers. The supplier is therefore required to co-ordinate the control and wiring schematics of these control and relay panels with control and wiring schematic of the outdoor equipment manufacturer.

2. The purchaser will intimate the supplier the details of the outdoor equipments manufacturers on whom purchaser orders have been placed for the supply of these equipments along with such relevant details such as P.O. No. and date, delivery period,

and all other technical details such as rating data, wiring diagrams etc. The supplier shall co-ordinate these diagrams with that of the associated control and relay panels and shall also seek such clarifications as are necessary from these manufacturers under intimation to the purchaser.

3. The purchaser will assist and or furnish the supplier with all relevant data as are necessary for completeness of co-ordination of the wiring diagrams and interlocking of equipment circuits.

31.00 DRAWINGS AND LITERATURES:

31.01 Tender drawings and literatures:

The following drawings and literatures shall be submitted along with tender documents.

a) Principal layout drawings of the SIMPLEX control and relay panels with mimic bus, disposition of meters, control switches, relays and annunciator panel, synchronizing trolley etc. These layout drawings shall be for the following views:
   i. Front face of panel.
   ii. Inside view of panel.
b) Illustrated literature with photographs of similar panels supplied by themanufacturer.
c) Pictorial and sectional views of control switches, test terminal blocks, indicating instruments, exploded views of draw out type instruments etc.,
d) Printed copies of illustrated, literature, general technical data, performance application, and specifications of relays, fault locators, etc.,
e) Elementary schematic wiring diagrams of the various metering and protective schemes.

31.02 Contract Drawing:

In the event of an order, the supplier shall submit drawings, GTP and type test reports in triplicate for approval of the purchaser, prior to manufacture. After the drawings are approved six copies of each of the drawings printed on 90 GSM paper shall be supplied for immediate use.

The successful bidder should forward the drawings are as follows.

a) One set of reproducible, originals and 12 sets of blueprint copies of all approved drawings along with 12 sets of literature commissioning and maintenance manuals to the Chief Engineer, (Kaveri), BWSSB, KaveriBhavan, Bangalore -560 009.

b) Three sets of blue print copies of all approved drawings along with three sets of literature and manuals to each of the consignee.

c) Non supply or part supply of drawings, literature and manual will be deemed as incomplete supply of equipment.

The contract drawings shall cover the following

a) Principal layout drawing as per clause No. 31.01 (a).

b) Details of construction and dimensions of the cubicle and complete switch board.

c) Foundation drawings indicating the cable entries and trenches etc.

d) Elementary diagrams of all controls, metering, protection, annunciation and other circuits. All devices shall be numbered according to ASA code.

e) Cabling and wiring diagram of the front and rear cubicles and interconnections between them. Ferrule numbers device members, grouping for cable take offs etc., shall be distinctly shown.

f) Inter-connection diagram between switch board and switchgear equipment, power transformers, instrument transformers and other associated equipment.

g) Dimensional outline, drilling diagram and special mounting arrangement, if any, of each type of the various devices on the switch board.

h) Individual internal wiring diagram of all devices and elementary wiring diagrams or relays for internal wiring.

i) Construction details of the switches, terminal blocks and test blocks etc.

31.03 LITERATURE:

In the event of an order, seven copies of each set of the following literatures shall be supplied.

a) Literature describing construction, operation, testing, calibration, adjustment, rating, specifications, setting details of all the protective and auxiliary relays and control switches.

b) Literature giving rated data, details of adjustments for calibration for the indicating instruments and integrating instruments.

c) List of spare parts, identification number from removable parts of relays, instruments and switches etc., with the help of which the purchaser will be able to procure spare parts from the supplier at any subsequent time.

d) Performance application of relays.

e) Detailed internal drawings of all units / schematic diagrams of all, PCB's of the relays, reference voltages at convenient test points, functional description, operational details. This is essential for trouble shooting of the relays.

f) The literature shall contain wave forms / voltages etc at selected points for easy identification of faulty units within the modular unit.

32.00 **TESTS, TEST CERTIFICATES AND INSPECTION:**

32.01 The following routine tests shall be carried out on the panels at the factory:

a) Checking of overall dimensions, thickness of panel sheet and paint film.

b) Checking wiring and continuity of circuits.

c) One-minute HV withstand test – All equipment on panel and internal wiring shall be tested to withstand a voltage of 2KV to earth for one minute.

d) Insulation resistance of the complete wiring, circuit by circuit with all equipment mounted on the panel.

e) Verification of degree of protection as per IS –2147

32.02 All relays shall be subject to type tests and routine tests as per relevant standards, that is IS - 3231 or IEC - 255.

32.03 All other components including indicating instruments and accessories installed within the panel shall be subject to type tests, routine tests and acceptance tests according to the standards to which they conform.

32.04 All routine and acceptance tests shall be conducted in the presence of the purchaser’s representatives. No material shall be dispatched

unless the purchaser communicates his written approval to these test certificates.

33.00 Spares

33.01 The tenderer shall recommend in his offer a set of spares as are required for a period of 5 (five) years in respect of relays and instruments quoted. All like spare parts shall be interchangeable with respect to each other and shall therefore be suitable for the parts/components that they would replace.

33.02. The tenderer shall indicate the life expectancy or shelf life of all such spares and their recommended method of storage.

33.03 Itemized unit price rate for each component shall be furnished in the schedule of prices in tender proposal sheets. The purchaser reserves the right to order for the spares which in his assessment are actually required.

34.00 MAINTENANCE TOOLS AND EQUIPMENT:

34.01 a) The tenderer shall offer in his tender a set of special tools as are necessary for
routine maintenance and testing of the equipment. These shall include amongst others relay test jacks, patch cords, etc.

b) The tenderer is required to supply these tools arranged neatly in wooden boxes.

34.02 a) The tenderer shall offer in his tender, instruments and equipment's for conducting
tests on relays and instruments. The relay testing kits shall be suitable for conducting dynamic tests on the relays to ascertain their characteristics as also to conduct periodical calibration and maintenance tests.

b) The testing kits, shall be self-contained compact portable units with built in power supply units and timers. If the test equipment contains more than one unit then no extensive inter unit wiring shall be involved at site. The kits shall be capable of being operated off the auxiliary AC & DC power supplies specified in this tender document.

34.03 Itemized unit price rate of each such tool/equipment shall be furnished in the schedule of prices in tender proposal sheets.

35.00 QUALITY ASSURANCE PLAN:

The tenderer shall invariably furnish the following information along with his offer failing which his offer shall be liable for rejection.

a) Names of sub-suppliers of individual accessories.
b) Information and copies of test certificates in respect of bought out accessories.
c) List of manufacturing facilities available.
d) List of areas in manufacturing process where stage inspections are carried out for quality assurance and details of such tests and inspection.
e) Type test certificates not older than three years as on the previous date of tender opening.

35.01 The supplier shall within 30 days of placement of order, submit following information to the purchaser.

i) List of bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
ii) Type test certificates of the bought out accessories.
iii) Quality assurance plan (QAP) with hold points for purchaser's inspection. The quality assurance plan and hold points shall be discussed between the purchaser and supplier before the QAP is finalised.

35.02 The supplier shall submit the routine test certificates of bought out items, at the time of routine testing of the fully assembled panel.

36.00 MINIMUM EXPERIENCE FOR QUALIFYING AS A TENDERER:

i. Tenderers shall have a minimum experience of five years in the design, manufacture, testing and commissioning of Control and Relay panels, similar to the type specified in the present enquiry. At least 50% of the quantity of similar type of main protection relays i.e., distance and differential, over fluxing, REF relays and Bus bar protection relays called for in the present enquiry shall be in successful operation for a minimum period of two years. The tenderer shall furnish performance certificate for satisfactory operation of similar main protection relays for a minimum period of two years. The tenderer shall furnish the type test certificates for tests conducted on a similar relay not later than three years from the previous date of bid opening.

ii. The tenderer should be the original manufacturer of at least 50% of the total relay types mentioned, viz., distance relays, auto re-close relays, differential relays and back up protection relays, High speed trip relays, LBB, Bus bar protection relays, over-fluxing and REF relays.

iii. The purchaser however reserves the right to waive the minimum experience condition stipulated in clause 36.00 (i) in case of Firm having collaboration with well experienced Firms. The experience of the collaborating Firms in the manufacture of

similar type of main protection relays shall be not less than five years. The waiving of minimum experience condition will be considered by the purchaser only on furnishing the performance guarantee for the main protection relays manufactured by the collaborating Firms.

37.00 PERFORMANCE GUARANTEE:

The control and relay panels along with the main protection relays offered shall be guaranteed for satisfactory performance for a period of 24 months from the date of satisfactory commissioning of C & R Panels. The equipment/relays if found defective/failed within the above guarantee period shall be replaced or repaired by the supplier free of cost within one month from receipt of intimation. If the defective/failed equipments/relays are not replaced/repaired as per the above guarantee clause, the corporation shall recover an equivalent amount plus 15% supervision charges from any of the supplier's bills.

38.0 TRAINING TO BOARD ENGINEERS:

38.01 The purchaser requires that training be imparted to eight Engineers of the Purchaser's organization in the testing, commissioning, calibration, adjustment, trouble shooting and attending to routing defects, mal-operations in the relays and instruments supplied. Such training shall be imparted at the supplier's works for a period of not less than 2 (two) weeks and shall be imparted free of cost. The to and fro travel expenses of these Engineers will be borne by the purchaser. However, boarding, lodging and other incidental expenses related there to shall be borne by the supplier.

38.02 In case training is to be imparted at the works of the supplier's collaborators. Then the same shall be arranged for by the supplier.

38.03 The training shall be imparted before dispatch of the equipment.

39.0 DESPATCH:

39.01 The control and relay panels shall be dispatched in suitable crates with all instruments, relays, switches and other devices mounted in position and wired. Instruments which cannot be sent in this manner may be separately dispatched.

39.02 The detailed dispatch schedule for each control & relay panel board shall be supplied well in advance. In the schedule, items accompanying the control panel items separately dispatched in crates and items for which only drilling and wiring is provided shall be separately listed.

39.03 The packing list for each shipment shall indicate complete details of equipment being shipped to enable to consignee to identify the parts and to ensure that no equipment stated to have been shipped has either lost in transit or if damaged, to initiate replacement proceedings and also to enable the insurance claims to be preferred.

If the invoice does not contain full details, if any part not specifically mentioned in the packing list is missing in transit the supplier shall be responsible for supply of such parts to the purchaser without any extra cost.

40.0 DEVIATION FROM TECHNICAL SPECIFICATIONS:

40.01 The tender can suggest modification in the protective scheme detailed in the specification if it improves the discrimination selectivity and overall performance of the protection scheme, clearly giving all the details.

41.0 SCHEDULE OF REQUIREMENTS AND DELIVERY:

41.01 The schedule of requirement of components is detailed in annexure. The tenderer should furnish the breakup prices for various relays and meters for future addition and deletion.

41.02 Station wise schedule of requirement along with the desired delivery is detailed in Annexure. In case of new stations the basis of comparison will be on package basis i.e. on the complete requirement of a station.

41.03 The purchaser may ask for addition or deletion of some items during the time of verification of drawings. The Firm shall agree to supply any additions(at extra cost, if any).

41.04 In view of 41.04 and also due to other reasons, there may be change in the components of the panels which will be decided at the time of approval of drawings. In the event of difference of components between purchase order and approved drawing, payment will be made as per approved drawing.

42.00 SCHEDULE OF PRICE:

42.01 The tenderer should furnish the schedule of prices for each type of panel station wise. The supplies should be complete in all respects as stipulated in annexure and preference will be given to tenderers who confirm that this delivery can be met. The tenderer should indicate in this offer the breakup of time required for (1) collecting design parameters from purchaser, (2) Designing of panels and preparation of detailed drawings, (3) Approval of drawing, (4) fabrication of panels and testing and (5) transportation to site. This information will be used for the purpose of calculating penalty etc.

42.02 The tenderer shall furnish the breakup price for each of the component of panels. Decision in regard to adding or deleting any of the component rests with the purchaser.

43.0 GUARANTEED TECHNICAL PARTICULARS:

43.01 The tenderer should furnish the guaranteed technical particulars as called for in Annexure, failing which the offer is liable to be overlooked.

43.02 Guaranteed technical particulars for panels for different voltage class shall be furnished separately.

ANNEXURE – CRP – 1

CONTROL, METERING AND RELAY PANEL FOR 66 kV FEEDERS IN 66kV SUB STATIONS (FTYPE 6L6 –A FOR 66 kV FEEDER)

The Simplex C & R Panel shall generally consist of following items.

A CONTROL AND INDICATION PANEL:

Sl. No.	Particulars	Quantities 6 L
1	METERING DEVICE	
	a) AC ammeter dual range 0-200/0-400 Amp or 0-400/0-800(with transduced for SCADA operation & monitoring)	3 Nos.
	b) AC wattmeter with center zero, range in MW (with transduced for SCADA operation & monitoring)	1 No. 25-0-25/ 50-0-50
	c) AC MVAR meter with center zero, range in MVAR (with transduced for SCADA operation & monitoring)	1 No. 25-0-25/ 50-0-50
	d) AC 3 phase, 4 wire electronic trivector meter accuracy 0.2 (with transduced for SCADA operation & monitoring)	1 No.
	e) Test terminal block	1 No.
2	CONTROL DEVICES:	
	a) Control switches for remote Control of 110/66 kV CB	1 No.
3	INDICATION AND ANNUNICATION DEVICE	
	a) CB status indication lamps with accessories	1 Set
	b) Isolator status indicating lamps with all accessories	62Sets Refer notes
	c) AC indicating lamp for DC fail	1 Set
4	OTHER DEVICE:	
	a) PVC Circuit label	2 Nos.
	b) Painted Aluminium strip showing the single line diagram	1 Set
	c) Internally mounted equipment	1 set
	d) Label indicating manufacturer’s name, PO details, drawing reference no. etc.,	1 No
	e) Annunciation windows with etching, lamps, Test/acknowledge/ reset push buttons etc.,	1 Set
	f) Selector switch for selecting Remote/SCADA.	1 No

B RELAY PANELS:

1	MAIN PROTECTION RELAYS	
	a) Numerical distance scheme suitable for 3 phase tripping with other features as described in the detailed specification	1 Set
2	BACK UP PROTECTION	
	a) Directional over-current potentially polarized IDMT relays without instantaneous elements	2 Nos
	b) Directional earth fault potentially polarized IDMT relays without instantaneous elements	1 No
3	**AUXILIARY RELAYS:**	
	a) Trip circuit supervision relays	2 Sets
	b) Tripping relay (1 for main 1 for backup protection)	1 Set
	c) DC supply monitoring relay	1 Set
	d) Annunciation relays and other relays	As required
	e) Contact Multiplier relay for SCADA operation	As required
4	**OTHER DEVICES**:	
	a) Test terminal box	If required see note
	b) PVC circuit labels	2 Nos
	c) Label indicating manufacturer's name, PO details, drawing reference no. etc.,	1 No
	d) Internally mounted equipments	1 Set

NOTE:

1. Other accessories required for operation of the protective Scheme including interconnections shall be included.

2. Numerical distance scheme shall be suitable for all line lengths. Any limitation shall be clearly specified.

3. Separate fuse failure relay with suitable annunciation is to be provided in case the same is not in-built.

4. Optional reading devices, software etc., required for setting, reading of the meter etc., deemed to be included.

5. The devices in addition to name plate, shall have labels indicating the function that are part of that particular relays and their codes in the drawings.

6. Common bell, hooter, associated annunciation relay can be located in any one of the 110/66/33KV panels and shall be separate for each voltage class and can be mounted in one of the line /bus coupler panel of the same voltage class.

7. TTB for protection circuit to be provided if the relay are of non draw out type.

8. Transducer shall be provided for WATT meter / VAR meter.

ANNEXURE – CRP – 2

CONTROL, METERING AND RELAY PANEL
66/6.6kV DELTA-STAR POWER TRANSFORMER

(TYPE 6T1-A FOR 66/6.6kV TRANSFORMER)

The SIMPLEX C& R Panel shall generally consist of the following items.

A CONTROL AND INDICATION PANEL:

Sl. No.	Particulars	
1	METERING DEVICE	
	H V SIDE:	
	a) AC ammeter Range 0-100/0-200/0-400 Amps (with transduced for SCADA operation & monitoring)	3 Nos.
	b) AC 3 phase wattmeter dual ranges(with transduced for SCADA operation & monitoring)	1 No
	c) AC 3 phase, MVAR meter with center zero, dual range 25-0-25 MVAR(with transduced for SCADA operation & monitoring)	1 No
	d) AC 3phase, 4 wire electronic trivector Recording meter accuracy 0.2(with transduced for SCADA operation & monitoring)	1 No.
	e) Test terminal block	1 No
	MV SIDE:	
	a) AC Ammeter Range (0-200 / 0-400 A) **(**with transduced for SCADA operation & monitoring)	---
	b) AC 3 phase, 4 wire electronic trivector meter of accuracy 0.2**(**with transduced for SCADA operation & monitoring)	1No
2	**CONTROL DEVICES;**	
	HV SIDE:	
	a) Control switches for remote control of 66 kV CB	1 No
	MV SIDE:	
	d) Control switches for remote control of 33 KV CB	---
3	**INDICATION AND ANNUNICATION DEVICE:**	
	HV SIDE:	
	a) CB status indication lamps with all accessories	1 Set
	b) Isolators status indication lamps with all accessories	2 Sets
	c) AC indication lamp for AC fail	1 No
	MV SIDE:	
	a) CB Status indication lamps with all accessories	---
	b) Isolator status indication lamp with all accessories	---
4	OTHER DEVICES	
	a) PVC Circuit label	2 Nos
	b) Painted Aluminium strip mimic showing the single line diagram	1 Set
	c) Internally mounted equipments	1 Set

	d) Label indicating manufacturer’s name, PO details , drawing reference number etc,	1 No
	e) Annunciation windows with etching, lamps, test/acknowledge /reset push buttons etc.	1 Set.

B RELAY PANELS:

Sl. No.	Particulars	
1	**MAIN PROTECTION RELAYS:**	
	a) Triple pole, high speed. Percentage bias numerical differential relay with high set instantaneous element, suitable for two winding transformers, with universal ratio ICTs	1Set
	b) Numerical Restricted earth fault relay	1 No
2	**BACK UP PROTECTION:**	
	a) Directional over current potentially polarized IDMT relays with high set instantaneous elements (on HV side)	3 Nos
	b) Directional over current potentially polarized IDMT relays with high set instantaneous elements (on MV side)	--
	c) Directional earth fault potentially polarized IDMT relays with high set instantaneous elements (on HV side)	1 No
	d) Directional earth fault potentially polarized IDMT relays with high set instantaneous elements (on MV side)	---
3	**AUXILIARY RELAYS:**	
	a) Trip circuit supervision relays (HV side) (To be provided in control panel)	2 Sets
	b) Trip circuit supervision relays (MV side) (To be provided in control panel)	2 Sets
	c) Inter tripping relay (To trip both HV & MV side of the transformer)	1 set
	d) DC supply monitoring relay	1 Set
	e) Auxiliary relays for Buchholz trip/alarm, oil temperature high trip/alarm, winding temperature high trip/alarm etc., for HV & MV	
	g) Other annunciation relay & other relays	
4	OTHER DEVICES:	
	a) Test terminal block	
	b) PVC Circuit labels	
	c) Label indicating manufacturers name, PO details, drawing reference, number etc.	1 No
	d) Internally mounted equipment’s	1 Set

Note: Refer Note of Annexure CRP – 1, wherever applicable.

ANNEXURE – CRP – 4

CONTROL, METERING AND RELAY PANEL FOR 110/66 kV FEEDERS IN 220KV SUB-STATIONS. (FTYPE 6L – FOR 66 kV FEEDER)

The Duplex / Simplex C & R Panel shall generally consist of following items.
Note: The Control Voltage for these C & R Panels is 110V DC

A CONTROL AND INDICATION PANEL:

Sl. No.	Particulars	Quantities 6 L
1	METERING DEVICE	
	a) AC ammeter dual range 0-200/0-400 Amp	3 Nos.
	b) AC wattmeter with center zero, range in MW	1 No. 25-0-25/ 50-0-50
	c) AC MVAR meter with center zero, range in MVAR	1 No. 25-0-25/ 50-0-50
	d) AC 3 phase, 4 wire electronic trivector meter accuracy 0.2	1 No.
	e) Test terminal block	1 No.
	f) Bus VT selector Switch/relay	1 No.
2	CONTROL DEVICES:	
	a) Control switches for remote Control of 110/66 kV CB	1 No.
	b) Control switches for remote Control of 110/66 kV Isolators	5 Nos.
	c) Synchronizing selector switch	1 No.
	d) Synchronizing socket (6 / 12Pin)	1 No.
	e) Selector Switch for selecting transfer trip with suitable label and locking device.	1 No.
3	INDICATION AND ANNUNICATION DEVICE	
	a) CB status indication lamps with accessories	1 Set
	b) Isolator status indicating lamps with all accessories	6 Sets Refer notes
	c) Indicating lamps for selection of transfer trip	1 Set
	d) AC indicating lamp for DC fail	1 Set
	e) Bus VT selection indicating lamp	1 Set
4	OTHER DEVICE:	
	a) PVC Circuit label	2 Nos.
	b) Painted Aluminium strip showing the single line diagram	1 Set
	c) Internally mounted equipment	1 set
	d) Label indicating manufacturer’s name, PO details, drawing reference no. etc.,	1 No
	e) Annunciation windows with etching, lamps, Test/acknowledge/ reset push buttons etc.,	1 Set

B RELAY PANELS:

1	MAIN PROTECTION RELAYS	
	a) Numerical distance scheme suitable for 3 phase tripping with other features as described in the detailed specification	1 Set
2	BACK UP PROTECTION	
	a) Directional over-current potentially polarized IDMT relays without instantaneous elements	2 Nos
	b) Directional earth fault potentially polarized IDMT relays without instantaneous elements	1 No
3	**AUXILIARY RELAYS:**	
	a) Trip circuit supervision relays	2 Sets
	b) Tripping relay (1 for main 1 for backup protection)	1 Set
	c) DC supply monitoring relay	1 Set
	d) Annunciation relays and other relays	As required
	e) Breaker failure relay	1 No.
4	**OTHER DEVICES**:	
	a) Test terminal box	If required see note
	b) PVC circuit labels	2 Nos
	c) Label indicating manufacturer’s name, PO details, drawing reference no. etc.,	1 No
	d) Internally mounted equipments	1 Set

NOTE: Refer Note of Annexure CRP-1, wherever applicable.

ANNEXURE – CRP –ANW

SCHEDULE OF REQUIREMENT OF ANNUNCIATOR WINDOWS

I 66 kV LINE PANELS:

TRIP ALARMS:

1. Distance protection operated.
2. DOCR/DEPR operated.
3. Local panel back up protection operated.

NON-TRIP ALARMS:

1. Trip circuit supervision alarm TC1.
2. Trip circuit supervision alarm TC2.
3. VT fuse failure alarm.
4. Carrier failure.
5. SF6 gas pressure low.
6. Air pressure low.
7. DC fail distance protection/ control circuit.
8. Breaker lockout
9. Spare one no.

II POWER TRANSFORMER PANEL 66/6.6 kV:

A TRIP ALARMS:

1 . Differential relay trip operated,
2. REFR operated.
3. Transformer over current relay operated.
4. Transformer earth fault relay operated.
5. Buchholz trip operated.
6. Oil temperature high trip.
7. Winding temperature very high trip,
8. OLTC surge relay trip/diverter switch trip.
9. Pr. Relief device trip.
10. Local breaker back up protection operated.

B NON TRIP ALARM:

1. Buchholtz alarm.
2. Winding temperature high.

3. Oil temperature high,
4. Trip circuit supervision TC 1.
5. Trip circuit supervision TC2.
6. Circuit breaker lockout.
7. Transformer control DC fail.
8. SF6 gas pressure low.
9. Air pressure low,
10. Transformer oil level low.
11. Spares four nos.

ANNEXURE – CRP –TVM

TECHNICAL SPECIFICATION FOR 1 AMPS STATIC ELECTRONIC TRIVECTOR METERS OF ACCURACY CLASS FOR 0.2 S – **WITH ABT FEATURES**

1. The specification covers design, Manufacturing, Testing, Supply & Delivery of HT and/or LT, Static 3 Vector Energy meter, capable of measuring Electrical energy & demand in balanced and/or unbalanced loads. The accuracy class and Current rating are stated along with the requirements.

2 STANDARDS:

While drafting this specification, reference has been made to the following Indian and International standard specifications. In case certain details are not covered in 1hese specifications any other Indian/ International standard shall be applicable.

1. IEC 60687 for Class 0.2 S
2. IEC 1268 for Class 1.0 Reactive Energy
3. IEC 1000-4-2, for Electrostatic discharge
4. IEC 1000-4-3, for Electromagnetic high frequency discharge
5. IEC1000-4-4, for Electrical fast transient/burst
6. IEC/CISPR 14, for Radio interference
7 Technical report of specification for AC Static Electrical Energy Meters CBIP, New Delhi
8 IEC 62056: 1997for communication protocol.

3 QUALIFYING REQUIREMENT:

The meter manufacturer should have supplied at least 5000 meters of similar type either in India or internationally.

4 a) CLIMATIC CONDITIONS

The meters shall be suitable to work satisfactory under the following climatic conditions.

i. Minimum ambienttemperature 0 deg C
ii. Maximum ambienttemperature 50 deg C

iii.	Minimum relative Humidity	26%
iv.	Maximum relative Humidity	100%
v.	Altitude	up to 1000 m above sea level.

b) SUPPLY SYSTEM ENVIRONMENT

a) Meters shall be suitable for both balanced and/or unbalanced loads at all power factors in all the four quadrants meter shall display direct reading without built-in multiplying factor. The meters shall be suitable for working satisfactorily with following supply system variations.

(i) Operating voltage range of the meter : V_{basic} + 20 % to - 40 %

(ii)Operating Current Range : Two times I_{basic}

(iii)Frequency : 50 Hz ± 5 %

(iv)Power-factor Range : ±1%

b) Meter should work accurately irrespective of phase sequence of supply

c) Meters shall be of Universal type i.e, the meter shall be configurable for 3 Phase 4 wire configuration depending on the external power supply arrangement.

d) Meter shall not get damaged if phase and neutral is interchanged

5 QUANTITIES TO BE MEASURED AND MONITORED

The meters shall be capable of measuring and displaying the following electrical quantities within accuracy requirements as stipulated in clause 4.6 of IEC 1036 for poly-phase balanced and/or unbalanced loads. The meters shall be capable of measuring 5OHz and Harmonic Power up to 29th Harmonics.

i)	Phase wise Voltage and Currents	:	V, I
ii)	Active Energy, Reactive Energy, Apparent energy	:	KWH, KVAH, KVARH
iii)	Maximum demand	:	KVA, KW, KVAR
iv)	Power factor	:	P.F
v)	Frequency	:	F

The Data shall not be lost in the case of Power Failure

Measuring principles are as per the Appendix - II

6 DESIGN REQUIREMENT

i) Voltage dips and short interruptions shall not produce a change in the register for more than 0.001 KWH, KVAH when the voltage is restored. The meter shall not have suffered
degradation of its metering characteristics.

ii) The voltage circuit of the meter should withstand the impulse voltage test as per IS: 13010.

iii) The following disturbances shall be considered in the design of the meter to overcome the effect of errors due to:

- Harmonics
- voltage dips, interruptions and Voltage fluctuations
- Conducted Transients
- DC and AC Magnetic fields
- Electro-magnetic fields
- Electro-static discharges

The meter shall be designed in such a way that the above disturbances do not damage the meter. The meter shall not generate electromagnetic, electro-static disturbances which could interfere with other equipment. The limits of error variation for the above abnormal 'conditions shall be as per relevant standards.

iv) The meter shall be based on digital measuring principle.

v) The meters shall provide real time information and display loading conditions and anti-tamper diagnostic conditions.

vi) The meter shall have built in Modem for remote communication purpose. Alternatively, meter shall have provision for upgrading on a future date.

vii) The meter should work even if anyone phase supply i.e., either phase to ground or phase to phase is available. It shall record and store all parameters under these conditions.

viii) The meter shall be suitable for direct connection without using External Transducers or devices

ix) The meter shall be able to operate and sense the input supply from 70 to 415 volts phase to phase, 4 wire system

x) The meter shall have AC voltage withstanding capacity of 4 kV at 50 Hz per minute.

xi) The Meter Impulse voltage resistance shall be not less than 10 kV / 50 micro sec.

xii) Drift in real time clock should be within 2 sec per month.

xiii) Design data shall also be furnished

xiv) The meter shall have the special feature to detect common ways to tamper and fraud as indicated in Appendix - IV

7. DISPLAY

i) The meter shall have legible Alpha-Numeric LCD displays, along with legend preferably of minimum of' 3 digits for parameter identification. Minimum dimension of each display character shall be of size 8-mm height and 5 mm width. Display with Electronic Back-Lit display arrangement for better visibility can also be offered

ii) Nomenclatures used in Display:

This shall be with universally accepted like kWH, kVA, kVARH and the abbreviations made for items like cumulative billing, ABT,TODetc. shall be clearly printed and narrated on the main cover of the meter itself.

iii) The details of requirement of scrolling parameters in automatic and manual modes shall be dynamically selectable at site without opening main cover, are furnished in Appendix - I.

iv) The meter shall have facility for indication of healthiness of battery and in the event of low battery condition the battery symbol shall be displayed,

v) The meter shall indicate the quadrant of operation

8. COMMUNICATION CAPABILITY:

i) The meter should be preferably provided with both RS232 and RS485 port to enable cascading meters in cluster and allow metering data of all the grouped meters to transfer through one communication channel

ii) All the meters shall have RS232 port for transfer of data from the meter to remote location

iii) In addition to the above the meter shall have optical interfacing for local reading or programming

iv) The data transfer from the meter either through optical I/F or through RS232/485 port shall be of open communication protocol. The protocol adopted shall confirm to ANSI Standards / European standards.

v) The bidder should clearly state the adopted protocol. It is deemed as part of the tender that the bidder will supply the required software for analysis of downloaded data on either Oracle platform or any other platform mutually agreed.

The bidder shall part with protocol details for development of any other programs required for analyzing the data through third party for the following:

a) Load profile memory
b) Blackout Register
c) Demand Violation
d) Exceptional reports
e) Diversity and Load Factor

vi) The meter shall be compatible to external communication equipment using any one thefollowing technologies which can be designed by third party.

a. PSTN
b. GSM
c. VSAT
d. RADIO
e. PLCC

9. ADDITIONAL FEATURES REQUIRED

a) The meter shall have provision for ABT/TOD tariff with the following features

i) Programmable upto 6 Energy and Demand registers.

ii) Programmable upto 4 seasons per year

iii) Provisions for assigning any particular day of the week to one or more registers.

b) In case if the bidder guarantees life of the battery for 10 years and if average life of the battery is found to be less and if the same cannot be replaced without opening main cover, then the bidder is liable for entire cost of replacements.

c) The Integration time for load survey parameters shall be selectable at site using Password without opening Factory seals. The Integration period shall be selectable between 1 min to 60 min in suitable steps.

d) The meter shall have provision to store maximum demand occurred during the integration period selected for KW, KVA and KVAR parameters during a month. The meter shall monitor the demand during the period set and record for each of the ABT/TOD zones the maximum registered values during the particular month.

e) The meter shall have provision for maximum demand resetting automatically at the end of Zero hours on the first day of every calendar month and also through an external push button. The meter shall keep track of such resets and display cumulative value of such

resets. As an added feature History of few number of resets can also be offered

f) The meter should register energy even when the load is not terminated back to the meter though a neutral.

g) The meter shall be capable of recording occurrences of missing potential in any of the phases and its restoration with date and time and occurrences. The details of cumulative accounts of such occurrences and cumulative period shall also be available as part of external data output.

h) The Load Survey Parameters to be stored in memory shall be cumulative consumption of KWH, KVAH and KVARH during the integration period. In addition the meter shall have provision to store average value of voltages, Currents and Frequency. The minimum memory set shall be sufficient to store half an hour value of at least 8 parameters for 35 days on FIFO basis.

i) The meters shall identify and store in memory all occurrences and 'reset of unbalanced voltages / currents in line / phase current. The trigger value shall be furnished to the successful bidder.

j) The meter shall have self-diagnostic facility. It shall check periodically its performance of its electronic circuits and software. The meter shall give error message on display in case of detection of any mal functioning within the meter and also as part of external data. The self-diagnostic features shall cover the following:

i) Performance of electronic circuits and software
ii) Missing Potential
iii) Low battery condition
iv) Attempt to communicate with the meter without proper Password

k) Meter shall have Provision for setting R T C of the meter periodically within ± 1 minute at the time of taking readings. The drift of the R T C and new setting shall be given in the printout.

l) The meters Preferably shall have facility for storing daily midnight value of cumulative kWH, kVARH and kVAH for 35 days on FIFO

m) The meter shall have minimum of five security levels

(i) For downloading data

(ii) for changing display Parameter of auto-scrolling

(iii) For changing Parameters of load survey.

(iv) For changing TOD register, time etc.

(v) Measuring principle, computation, self-diagnostic features.

The security shared with user shall be without opening main cover. However, it is the responsibility of the meter manufacturer for the safe keeping of Password for the Security level which gives access to meter measuring principle, computation, self-diagnostic feature etc. Any losses incurred to the corporation in view of the leakage of the security level will be charged to the manufacturer.

10 ACCURACY and GUARANTEE:

The accuracy shall be corresponding to the accuracy class stipulated in the relevant standards for 0.2 S.

Each meter shall be guaranteed for its design, performance and accuracy for a period of ten years. If the meter goes faulty during the period of guaranteed performance and accuracy, it shall be replaced within 30 days failing which the firm will be blacklisted for further orders. If replacements are not made within stipulated period, corporation reserves the right to procure meters from outside sources for replacements and recover the cost of the same.

11 CONSTRUCTION OF METER:

a) The meter shall be made of high quality bakelite or other improved insulating material totally unaffected by radio frequencies, higher reliability and longer life shall be ensured. The casing and terminal cover should be sturdy enough to prevent damage during transport and installation. The meter shall be reliable in design and should be of surface mount technology, easy to transport and immune to vibration and shock. The case shall be so constructed such that any non-permanent deformation does not prevent the satisfactory operation of the meter.

i) All the insulation materials used in the construction of the meter shall be non-hygroscopic, non-ageing, and of tested quality. Construction of the meter should be such that it can be sealed independently and secured in such a way that the internal part of the meter shall be accessible only after breaking the seals and ensure prevention of tampering. The cover shall not be removable without the use of the tool. For degree of protection against dust and moisture the meter shall conform to IP 53 as per IS 12063/ IEC 529.

ii) The base of the meter should have terminal block to facilitate front connection. The terminal block should satisfy all conditions specified in IEC 1036 and IS 13779. the terminal cover should have separate sealing facility.

iii) The various displays on the meter should have facility for cycled through up and down push button.

iv) The resetting of MD shall be achieved through a push button provided in front of the meter with sealing provision or automatic at 00: 00 Hours of the beginning of the month.

b) Every meter shall be indelibly marked with a connection diagram and abbreviations used. If the meter terminals are marked, this marking shall appear on the diagram. Tie diagram shall be either on the meter or inside of the terminal cover.

12 MARKING AND NAME PLATE:

Every meter shall be marked with the following Information and the marking shall be indelible, distinct and clearly visible from outside the meter:

a) Manufacturer's name or trademark and the place of manufacture.

b) Design of type which should not be same for any two of designs of meters.

c) Principal unit in which the meter records. (for kWH,kVARH)

d) Base voltage, Current and Frequency

e) Purchase order and Date.

f) The month and year in which the Guarantee period Expires.

g) Identification Number

13 ACCESSORIES OF THE METER-

Each meter should be accompanied by its Test certificate, present configuration, Software for downloading, Detailed literature, Suitable lugs for current and voltage circuits.

i) Necessary hardware for reading the meter through optical interfacing unit, and RS232 / RS485 port.

One set of such kit shall be supplied for every 50 meters ordered.

ii) The Bidder shall also supply suitable calibrator and Test Equipment for Testing the accuracy of the meter, communication capability etc. The calibrators offered shall have Memory to store at least 100 No's previous calibrations test results and facility for taking a print with a portable external printer. The Accuracy class of reference meter shall be as recommended in relevant Standards for that class of meter. The necessary scanner having suitable optical head is deemed as part of the specifications. One

set of Test equipments shall be supplied with every 500 meters or part thereof.

In case the calibrator does not have memory to store all the information downloaded from the meter, then one Laptop PC shall also be supplied per Calibrator for collecting the information from the meter memory.

The Bidder shall also supply necessary equipments to check the external communication outputs.

14 TESTS: TYPE TEST, ACCEPTANCE AND ROUTINE TESTS

Latest type test certificate issued only for the tender sample model has to be submitted in full and the copies shall be legible / valid.

The hard copies of the output that can be obtained through base computer from the data downloaded shall be submitted along with the bid

Recommended Type tests., Acceptance and Routine Tests are as per the table at Appendix V

Sampling plan while conducting Type/ Routine tests shall be as per IS :4905

APPENDIX - I

List of display parameters required:

Scrolling Parameters

A) BILLING PARAMETERS

1. Meter Serial number.

2. Time, Date, Month, Year

3. Billing kWH - (Universal ABT/TOD Register)

4. Billing kVA, kW MD in ABT/TOD Register (Universal ABT/TOD Register)

5. Billing P.F - (Universal ABT/TOD Register)

6. MD Reset count MD last reset date

7. Self diagnostic display

B) INSTANTANEOUS PARAMETERS

1. Phase wise Currents
2. Phase wise voltages
3. Instantaneous average P.F
4. Demand with elapsed time
5. Running period MD, P.F
6. Frequency

C) CUMULATIVE PARAMETERS OF UNIVERSAL (00-24 Hours) REGISTER.

1. kWH
2. kVAH
3. kVARH Lag & Lead
4. kVA MD, kW MD, RKVA MD

D) HIGH RESOLUTION MODE

1. kWH
2. kVAH
3. RkVAH
4. Phase wise angles between Voltages and Currents

E) TOD Zone and time slabs

Note: The parameters for Automatic scrolling display shall be dynamically selectable through user's password and without opening of main cover

APPENDIX - II

Measuring principle to be adopted for KVAH and PF

$kVAH = \sqrt{(kWH^2 + kVARH^2)}$ for lagging PF

kVAH = kWH for leading PF (RKVAH = 0)
(only for consumer meter or single quadrant meters)

PF = (kWH) / (kVAH)

Note : In case of single quadrant meter, the energy transfer during current reversal condition shall be added to the main register. However, it is preferred in addition to the above, if energy transfer in this quadrant is available in an independent register.

APPENDIX - III

Software requirement

1. Dynamic selection of scrolling parameters, demand sub-intervals (Except universal register), TOD registers time interval configuration, shall be possible with users password and without opening main cover.

2. Along with Monthly bill Records, the following information shall be downloaded to MRI or PC.

   a) Meter ID, Time, Report date as HEADER in all pages
   b) Meter configuration consisting of the following Meter data i.e. Serial No., Software version, Hardware version, Base current and Voltage accuracy class, Pulse output, anomaly indication etc.
   c) All parameter values identified for scrolling display (i.e., auto scrolling and manual Scrolling)
   d) Cumulative counts and duration of all Tamper information
   e) Billing data of TOD Registers selected
   f) Status of all parameters that can be changed with user's password
   g) RTC time before taking monthly reading and after taking monthly reading.

3. On Demand

   a) Load Survey Data of all parameters, suitable software for obtaining Graphical and Tabular outputs of all the parameters over a selected period

   b) Detailed data of abnormal conditions occurred.

   c) Historical data of all cumulative parameters for previous 12 months.

   d) Historical data of software changes made.

   e) Historical data of cumulative parameter for previous 30 days (optional)

4. Remote Meter Reading

   a) Instantaneous Parameters

   b) All Parameters stated in Para 2 & 3

5. Software required on base computer

   a) Software for adding and sub-tracking load survey parameters of selected group of meters over a period of time..
   b) Selection of Instantaneous/tamper details during defined/selected Time Zones

c) Protocol information for analyzing all data read from the meters.

d) For generation of bills with the existing billing software.

APPENDIX - IV

Abnormal conditions to be identified on FIFO basis (First In First Out)

The meter shall be capable of recording the following conditions and restoration with duration and also the account of cumulative total number of such occurrences and cumulative duration. The number of events stored in the memory shall be minimum of 250Nos. One event means one set of occurrence and restoration of that disturbance.

1. Potential missing to the meter. (single phase or all phases)
2. Current reversal.
3. Unbalanced voltages and current.

APPENDIX - V

Test reports to be furnished:

SL No.	Tests	Laboratory name	Date of test	Test conforms to IS/IEC/CBIP specification	Remarks
1	**Test of insulation properties**				
1.1	Impulse voltage test				
1.2	AC voltage test				
1.3	Insulation resistance test				
2	**Test of accuracy requirements**				
2.1	Test on limits of errors				
2.2	Test of meter constant				
2.3	Test of starting condition				
2.4	Test of no-load condition				
2.5	Repeatability of error test				
2.6	Test of ambient temperature influence				
2.7	Test of influence quantities				
2.8	Measurement of phase current				
3	**Test of electrical requirements**				
3.1	Test of power consumption				
3.2	Test of influence of supply voltage				
3.3	Test of influence of short time over currents				
3.4	Test of influence of self heating				
3.5	Test of influence of heating				
4	**Test of electromagnet compatibility (EMC)**				
4.1	Radio interference measurement				
4.2	Fast transient burst test				
4.3	Test of immunity to electromagnetic HF field				
4.4	Test of electrostatic discharge				
5	**Test of climatic influence**				
5.1	Dry heat test				
5.2	Cold test				
5.3	Damp heat, cyclic test				

6	**Test of mechanical requirements**				
6.1	Vibration test				
6.2	Test of protection against penetration of dust and water				
6.3	Test of resistance to heat and fire				
7	**Software**				
7.1	Protocol				
7.2	Levels of security provided				
7.3	Levels of security provided to the users				

ANNEXURE – CRP –GTP

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF CONTROL EQUIPMENT AND RELAYS

	Bidder's Name	
Sl. No.	**Description**	
A.	**CONTROL & RELAY PANELS:**	
I	**Description, Construction & formation details:**	
1	Make and Type reference of manufacturer	
2	Type	
	i) type of construction(duplex or simplex)	
	ii) type of scheme (numerical type or static type)	
	a) for line	
	b) for power transformer	
3	Thickness of sheet steel (mm):	
	i. Door, Top and Bottom of panel	
	ii. Other	
4	Tentative overall dimensions (L*B *H) (mm) of each panel	
5	Dead weight of each panel (Kgs)	
6	Approximate weight of each panel with all components (Kgs)	
7	Details of packing for transport	
8	Overall dimensions of transport package (L*B*H) (mm)	
9	Approximate gross weight of transport package (Kgs)	
10	Exterior paint film thickness (microns) and paint colour	
11	Interior paint film thickness (microns) and paint colour	
12	Cubicle Lighting: Volts, wattage, Type of holder and fitting whether provided with door control switch or not.	
13	Safety earthing:	
	a. Material of conductor	
	b. Size (W*T) (mm)	
	c. Surface treatment and finish of conductor.	
	d. Type of end connection	
14	Panel front/rear component identity board	
	a. Material	

	b. Size	
	c. Size of lettering and colour	
	d. Method of fixing	

Sl. No.	Description	
15	Panel wiring:	
	a. Type and material of wire conductors, insulation and voltage grade.	
	b. Conductor cross sectional area or strands/gauge of wire and colour scheme adopted for:	
	i. VT secondary circuits and annunciation circuit.	
	ii. Other Circuits.	
	c. Type of wire termination	
16	Mimic bus details:	
	a. Type painted / strip fixed	
	b. Width (mm)	
	c. Whether colour scheme specified will be followed	
	d. If not specify deviations.	
II.	**TERMINAL BLOCKS AND CONNECTORS (USED FOR PANEL WIRING)**	
1	Make and Type reference of manufacturer	
2	Insulation and voltage grade	
3	Constructional details	
4	Current rating of studs, size and material	
5	Whether shrouding provided or not	
6	Whether space terminals provided or not	
7	Literature enclosed.	
III.	**INDICATING LAMPS:**	
1	Wattage and voltage of lamp	
2	Size of lens and material thereof	
3	Type of lamp holder	
4	Whether provided with series resistor? If yes, specify Ohmic value power loss	
IV	**FUSE HOLDERS AND FUSES:**	
1	Make and Type reference of manufacturer	
2	Insulation and voltage grade	
3	Type of Insulation material	
4	Type of fuses	
5	Rating of fuses provided for different circuits	
6	Literature enclosed.	
V	**CONTROL SWITCHES FOR ISOLATORS AND CIRCUIT BREAKERS:**	
1	Make and Type reference of manufacturer	
2	Type of switch:	
	a. For Isolators and CBs	
	b. Auto re-close	

	c. Transfer Trip	

Sl. No.	Description	
3	Number of possible positions of the handle for each type of switch.	
	a. No. of contacts available in each position	
	b. Maximum number of contacts which can be accommodated in each position.	
4	Number of lost motion type slip contacts in case of Isolators and CB switches.	
	a. After close	
	b. After trip	
	c. Maximum number of slip contacts possible	
5	Rating of contacts:	
	a. Voltage	
	b. Make and carry continuous current	
	c. Make and carry current for 1 Sec.	
	d. Breaking resistive load current.	
	e. Breaking inductive load current with L/R ratio of 40 milliseconds.	
	f. Type of contacts and surface treatment	
	g. Whether contacts shrouded.	
6	Whether locking arrangement is available	
7	Type of handle and standards, If any, to which it conforms.	
	a. Dimensions	
	b. Mounting details	
8	Whether detailed technical literature and drawings enclosed. (YES/NO)	
VI.	**SELECTOR SWITCHES:**	
1	Make and Type reference of manufacturer	
2	Type of handle / Switch	
3	Mounting details	
4	Number of positions	
5	Number of contracts available in each position.	
	a. Open	
	b. Close	
6	Making capacity of contacts	
7	Breaking capacity of contacts	
8	Whether locking arrangement is available.	
9	Whether detailed literature and drawings enclosed. (YES/NO)	
VII.	**PUSH BUTTONS:**	
1	Make and Type reference of manufacturer	

2	Mounting details	
3	Type of contact	
Sl. No.	**Description**	
4	Current and voltage rating	
5	No. of contacts	
	a. NO	
	b. NC	
6	Whether shrouding provided to prevent inadvertent operation (YES/NO)	
7	Whether provided with integral engraved inscription plates (YES/NO)	
VIII	**AUXILIARY CT's VT'S:**	
1	Make and Type reference of manufacture	
2	a. Type	
	b. Ratios available	
	c. Burden V A	
	d. Standard to which it conforms	
	e. Accuracy class	
	f. Short time current / voltage rating	
	g. Temperature rise	
	h. One minute power frequency withstand voltage	
	j. Mounting dimensional details	
	j. Weight	
	k. Panel in which to be provided with quantity thereof and connected ratio	
3	For CT's only	
	a. Knee point voltage (kPV) (Volts)	
	b. Excitation current at kPV and 50% KPV (ma)	
	c. Internal impedance of primary and secondary windings in ohms	
4	Literature enclosed.	
IX.	**SPACE HEATERS:**	
1	Make and Type reference of manufacture	
2	Type of space heater (Tubular / strip type)	
3	Rating Wattage	
4	Whether thermostat provided (YES/NO)	
B	**INDICATING INSTRUMENTS AND METERS:**	
I	The tenderer shall furnish guaranteed technical particulars for all types of meters offered, in the following proforma (separate sheet shall be enclosed for each type of meter :)	

1	Make and country of manufacture	
2	Type and rating	
3	Size and weight	
4	Mounting details	

Sl. No.	Description	
5	Rated VA burden and power consumption (In case of two energizing quantities the burden and consumption shall be furnished separately)	
6	Continuous overload rating of current / voltage coil	
7	Short time overload of current coil / potential coil	
8	Accuracy class and grade	
9	Adjustments provided	
10	Whether magnetically shielded (YES/NO)	
11	Details of topicalization	
12	Additional features provided	
13	Pointer position center zero / end zero	
14	Whether detailed literature enclosed. (YES/NO)	
15	Additional details for watt meter / V A R / Watt Hour Meter	
	a. Whether spare dial plates for different ration being provided.	
	b. Limits of error UPF at 125% and 10% of rated current.	
	c. Limits of error at 0.5 PF lag at 125%, 25% and 10% of rated current.	
16	Additional details for static watt hour meter	
	a. Type of registering mechanism	
	b. Display sequence	
	c. Parameters that can be measured	
	d. Whether the meter can be used to get demand details	
	e. Whether optical readout facility provided	
II	INSTRUMENT TEST TERMINAL BLOCKS:	
1	Make and Type reference of manufacturer	
2	Insulation class and rating	
3	Size and mounting details	
4	Type of CT terminal shorting mechanism (LINK / SCREW)	
5	Type of VT terminal Isolating Mechanism	
6	Whether detailed literatures enclosed. (YES/NO)	
C	**GENERAL PROTECTION RELAYS :**	
I	The tenderer shall furnish guaranteed Technical particulars for all types of meters offered, in the following proforma (separate sheet shall be enclosed for each type of relay	

	:)	
1	Manufacturer's name or trade marks	
2	Type designation	
3	Size and mounting details (whether in draw out case)	

Sl. No.	Description	
4	Rated Values of both input and auxiliary energizing quantities	
5	Values of the limits of the operative range(s) of the auxiliary energising quantity (ies)	
6	Contacts data, Number and rating of main and auxiliary contacts	
7	Rated value or setting range of the characteristic quantities and or angle	
8	Limiting short-time thermal withstand values	
9	Limiting dynamic values.	
10	i. Burden data (in case of poly input relays - data shall be furnished for appropriate set of input terminals).	
	a. At highest tap - AC current / voltage coil	
	b. At lowest tap - AC current / voltage (coil)	
	ii. DC power consumption.	
11	Impulse and dielectric test voltage(s)	
12	Details of accessories (If essential to the relay performance)	
13	Details of accessories (Optional items)	
14	Whether provided with seal in trip contacts	
15	a. Type of operating characteristics	
	b. Accuracy of operating characteristics, operating time with details	
16	H.F. disturbance test voltage (s)	
17	Whether literature enclosed	
18	Type of relay flag indicator and rating of target coil	
II	In addition to the above details, the following details shall also be furnished for relays specified below :	
1	**DOCR / DEFR :**	
	a. Directional sensitivity	
	b. Minimum voltage at which the directional units operate	
	c. Characteristic angle	
2	**OVER FLUXING RELAY :**	
	a. Whether provided with timer if so time setting available for Alarm and delayed trip.	
3	**Distance Protection Scheme for 220KV / 110KV / 66KV Lines:**	
A	Type of distance measuring element	
	a. Starting unit	
	i. Type of scheme	

	b, No. of measuring element or comparator with details	

Sl. No.	Description	
	c. Setting range of the distance measurement	
	d. No. of zones	
	i. Overall range for all zones.	
	ii. Reach setting range at rated current.	
	Zone - 1 (forward) - ohms	
	Zone - 2 (forward) - ohms	
	Zone - 3 (forward) - ohms	
	Off set zone 3 reverse - ohms	
	Zone extension (if any)	
	e. Characteristic of each zone	
	Zone - 1	
	Phase fault unit	
	Earth fault unit	
	Zone - 2	
	Phase fault unit	
	Earth fault unit	
	Zone - 3	
	Phase fault unit	
	Earth fault unit	
	Zone - 3 off set	
	Zone -1 in ohms	
	1. Reach of the relay along with characteristic angle at rated current and voltage	
	2. Reach of the relay in resistive direction at rated current & voltage	
	3. Reach in reactive direction at rated current & voltage	
	Zone - 2 in ohms	
	1. Reach of the relay along with characteristic angle at rated current and voltage	
	2. Reach of the relay in resistive direction at rated current & voltage	
	3. Reach in reactive direction at rated current & voltage	
	Zone - 3 in ohms	
	1. Reach of the relay along with characteristic angle at rated current and voltage	
	2. Reach of the relay in resistive direction at rated current & voltage	
	3. Reach in reactive direction at rated current & voltage	

Sl. No.	Description	
	Zone - 3 in Reverse ohms	
	1. Reach of the relay along with characteristic angle at rated current and voltage	
	2. Reach of the relay in resistive direction at rated current & voltage	
	3. Reach in reactive direction at rated current & voltage	
	f. Power swing blocking characteristic setting	
	i. Forward reach	
	ii. Reverse reach	
	g. Setting range of residual compensation	
	h. Setting range of mutual compensation	
	i. (i) Operating time	
	Zone - 1	
	(ii) Time setting range	
	Zone -2	
	Zone -3	
	Power swing blocking	
	j. Accuracy	
	Zone - 1 (reach)	
	Zone - 2 (reach)	
	Zone - 3 (forward reach)	
	K. Polarising scheme	
	Zone - 1	
	Zone - 2	
	Zone - 3	
B.	**<u>Additional features provided :</u>**	
	a. Fault locator	
	b. Carrier aided tripping scheme	
	c. Power swing blocking	
	d. Broken conductor detection	
	e. Synchronous check	
	f. Weaken infeed	
	g. Switch on to fault	
	h. Fuse failure supervision	
C.	**<u>Facilities available for Fault Locator</u>**	
	a. Name and type reference of manufacturer	
	b. Rating and setting available	
	c. Rated V A burden	
	d. Power consumption voltage and current	

	element	

Sl. No.	Description	
	e. Memory capacity with details	
	f. Triggering method	
	g. Accuracy	
	h. Method of accuracy	
4	Differential protection scheme :	
	a. No. of restraining coils and operating coils.	
	b. Harmonic restraints provided with details	
	c. Rated VA Burden and power consumption of	
	i. Restraining coil	
	ii. Operating coil	
	d. Type of slope setting: If variable, range of slope setting through fault current stability. Maximum & minimum range of HV / MV / LV current ratio over which the relay can be used.	
	e. Whether provided with switching inrush current restraint, if so type.	
III	The tenderer shall confirm whether the following details will be furnished at the time of approval of drawings:	
	a. Identification and location of removable parts.	
	b. Data of permit suitable connection of the relay (including the polarity)	
	c. Data concerning the earthing of metallic part	
	d. To indicate parts of modules which should not be replaced without observing precaution prescribed by the manufacturer.	
GUARANTEED TECHNICAL PARTICULARS ELECTRONIC TRIVECTOR METERS		
Sl. No.	**PARTICULARS**	
1	Type of Meter	
2	Class of Accuracy	
3	Standard to which the meter conforms	
4	Current rating for which accuracy is guaranteed for	
	a. Basic Current (i_b)	
	b. Continuous Current overloading capability	
	c. Short time over current	
	d. Minimum Starting Current	

5	a) Voltage rating for which accuracy is guaranteed for	
	b) Over voltage withstand capacity - continuous	
	c)Voltage Range	

Sl. No.	**Description**	
6	Other Parameters for which accuracy is guaranteed	
	a. Reference Temperature	
	b. Standard Reference Frequency (Hz)	
	c. Accuracy Guaranteed for	
	d. Frequency Range	
	e. For single Phase Loads / In- put	
	f. For two Phase Loads / In - put	
	g. For in-put / Loads without neutral in -puts unbalanced Voltages	
	h. Temperature Range	
	i. P F range	
	j. Time	
7	Insulation Resistance	
8	Sampling Plan for measurement of Voltage, Current and Frequency	
9	Power Loss in each Current circuit at Basic Current in VA & WATT	
10	Power Loss in each Voltage circuit at reference in VA & WATT	
11	Display device (Hardware details)	
	a. Type of Display i.e. LCD	
	b. Character size of display digits	
	c. No. of Display digits used	
	1. For data	
	2. For parameter identification	
	d. Life of display unit (Guaranteed)	
	e. Method adopted for digit overflow	
12	Display details (Software)	
13	a. Non-volatile memory retention time in absence of power	
	b. Non - volatile memory capacity in KB.	
	c. RAM Capacity	

	d. Maximum number of Parameters which can be stored in non-volatile Memory at each half an hour interval for Six Months.	
14	Maximum demand	
	a. Parameters that can be dynamically selected	
	b. Integration Period Range	
	c. Provision for Automatic Rest	
	d. Type of MD Computation	

Sl. No.	Description	
15	Communication Inter-phase available	
	- for calibration	
	- for data transfer	
16	Electromagnetic interference / Electromagneticcomparatively level	
17	Mounting arrangement	
18	Meter sealing arrangement	
	a. Meter body	
	b. Meter terminal block	
	c. MD reset bush button	
	d. Battery unit	
19	Degree of protection against moisture etc.,	
20	a. Provision for real time clock	
	b. Real time clock accuracy	
	c. Life of real time clock (Guaranteed)	
21	Power Supply backup	
22	Measuring principle employed for	
	a. kWH	
	b. kVAH	
	c. RkVAH	
	d. Maximum demand parameters	
	e. PF	
NOTE	1. Measuring principle adopted for each of the items above should be specified.	
	2. Measurement logic employed in case of Harmonics and contents up to which meter recognizes for measurement shall be furnished.	
23	Abnormal conditions that will be identified with limiting values	
24	Guarantee period offered for	
	a. Performance and accuracy	
	b. Components not covered under guarantee	
25	Micro processor	
	a. Address in bits	
	b. Sampling rate	
26	Compatibility of the software for the following	
	a. For generation of consumer bill directly with the existing BWSSB billing software	
	b. Compatibility of software provided for MRI, downloading from earlier version already supplied to BWSSB	

Sl. No.	Description	
	c. Compatibility of software for generation of report for earlier versions	
27	Additional features available	
28	Agreement to furnish protocol details for development of required software through third party	
29	Platform on which the meter communicates	
30	Levels of security	
	a. For changing real time	
	b. Fir changing display parameters	
	c. For changing Load survey parameters	
	d. For changing TOD Registers, clock setting	
	e. Measuring principle, computation	
31	Specification of reference standard offered	
32	Specification of Laptop Computer offered	
33	Specification of MRI kit offered	
34	Specification of equipment offered for checking communication capability through RS232/RS485 port	

SECTION – 10 :EARTH MAT

TECHNICAL SPECIFICATION

Sl. No.	Particulars
1	Laying of earth mat
2	Earth connections
3	Power Cables
4	Outgoing 11 KV Feeders
5	Sub-station Fencing
6	Crushed rock surface layer
7	Separation between C-I pipe electronics
8	Power cables & controls
9	Labeling of pipe electrode

TECHNICAL SPECIFICATION FOR INSTALLATION OF EARTH MAT IN SUB-STATION

1.0 LAYING OF EARTH MAT

1.1 While installing the earth mat, the rows and columns shall be interleaved like a woven mat to obtain better mechanical strength and electrical continuity.

MS flat of the designed cross section shall be laid at the designed depth of 0.9 M and spacing duly straightening and removing any bends.

1.2 As the standard length flats available in the market are around 6 meter in length for continues running of earth mat, straight joints are required. When such straight joints are made, a minimum overlap equal to the width of the flat shall be maintained.

1.3 The overlap portion shall be welded on all four sides by continuous welding. To facilitate welding on all four sides, welding work shall be done on the manual ground surface and then laid in the trench.

1.4 A thick coat of Anti-corrosive bituminous pass shall be applied at the welded joints duly removing the deposited weld flux and any burrs.

1.5 After laying the flats in the trench and interleaving, all the perpendicular crossings of flats shall be welded and applied a thick coat of ACB paint as above. The ACB paint shall be applied only to the welded portion.

1.6 Projections of flat at the periphery of the earth mat should be avoided and the overlap shall be in flush with the edge of the peripheral flat of earth mat at these joints the welding shall be continuous on all the three sides.

1.7 The peripheral MS round rods of length 1050 mm 25 mm dia shall be divert into the ground at locations shown in the earth mat drawing. Before diving these rods, the top 50 mm portion of the rod shall be flattened and bent and then welded properly to the MS flat of earth mat firmly. The other end of the rod shall be sharpened for easy driving.

1.8 When hard soils such as fissured rock/gravel, laterite etc., are encountered at the sub-station site during excavation for laying the earth mat, soft soil or tank clay shall be used for back filling in trenches of earth mat to a height of 0.3 mtr.

2.0 EARTH CONNECTIONS:

2.1 All earth connections from equipment/cast iron pipe electrode to the earth mat shall be made using Galvanised iron flats of cross section equal to the MS flat of earth mat.

All earth connections are to be made only by welding. Suitable lap sand ends shall be formed while making earth connections from equivalent to the earth mat.

2.2 POWER TRANSFORMER NEUTRAL

Two distinct continuous earth conductors (GI flats without any joints) shall be run in opposite directions from the Power Transformer neutral to the cast iron pipe electrodes provided for the purpose by welding. Further, these cast-iron pipe electrodes shall be connected to the earth mat by welding using GI flats.

2.3 LIGHTNING ARRESTERS:

Each phase of the lightning arrester base shall be connected to the cast iron pipe electrodes provided for that phase by running GI flat from the base terminal. The cast iron pipe in turn shall be connected to the earth mat by welding using GI flats. A flexible braided earth bond shall be made firmly between the base terminal and the GI flat. The length of the earth connection shall be as minimum as practicable.

2.4 OUTDOOR SWITCHGEAR AND CONTROL ROOM:

Minimum of the three-cast pipe electrodes are to be provided around both the outdoors switchgear and the control room. The opposite ends and mid points of the earth bus of these panels are to be connected to the earth mat through these cast iron pipe electrodes using GI flats.

If the earth bus provided in the panels are not continuous, a separate earth bus of GI flats shall be run along the panels on the power cable entry side and panel earth’s shall be connected to this bus which in turn should be connected to the earth mat through the cast iron pipe electrodes.

2.5 NON CURRENT CARRYING METAL PARTS:

All non-current carrying metal parts such as transformer body, circuit breaker body, instrument transformer body, outdoor structures and isolator structures are to be directly connected to the earth mat using GI flats with two distinct connections run in opposite directions.

The operating handles of isolators are to be connected to the earth connector (GI flat) using braided flexible earth bonds.

3.0 POWER CABLES

3.1 THREE CORE CABLES:

The sheath of the cables are to be directly earthed as their terminations and joints, i.e. at the both switchgear and terminating pot heads (cable sealing end)

3.2 Sheath on single core cable shall be earthed at only one end.

4.0 OUTGOING 11 KV FEEDERS:

4.1 When the feeders are erected within the substation fence :

The cable end leads sheath is to be earthed and connected to the earth mat through independent cast iron pipe electrode by running 50 x 6 mm GI flat along the structure from the cable end to CI electrodes intern these CI electrodes are to be connected to the earth mat. All these connections shall be made by welding.

4.2 When the feeders are erected out side the substation fence:

The lead sheath of the cable end shall be connected to CI pipe electrode of the feeders as mentioned in clause 4.1 further MS flat of 50 x 6 mm shall be run at a depth of 0.5 mtr. and all the CI pipe electrodes of 11 KV feeders shall be connected to this buried MS flat by welding using GI flats. This system shall not be connected to the station earth mat and should always be isolated from the station earth.

5.0 SUB STATION FENCING

5.1 Fence earthing shall be isolated from the main earthing of the substation.

5.2 The substation fence is provided at a distance of minimum 1.5 mtr. away from the edge of the substation earth mat.

5.3 A separate earthing conductor of size 50 x 6 mm MS flat should be run along the perimeter of the fence at a depth of 0.9 mtr. below the ground surface.

5.4 The perimeter of the fence is to be connected to this MS flat through independent vertical electrodes (CI pipe electrodes) using GI flat of 50 x 6 mm. The connections are to be made by welding.

5.5 The CI pipe electrode shall be provided at corners and mid points of the fence if the perimeter is more than 200 mm, otherwise CI pipe electrodes may be provided only at the corners or midpoints.

5.6 The fence earth and station earth mat shall not have nay-electrical tie.

5.7 The fence shall be minimum 1.5 mtr. away from station earth mat.

6.0 CRUSHED ROCK SURFACE LAYER:

25 mm metal (baby granite jelly) to a height of 100 mm shall be provided over the area as mentioned in the earth mat drawing.

7.0 SEPARATION BETWEEN CAST IRON PIPE ELECTODES:

7.1 The separation between any two CI pipe electrodes in the substation yard has to be maintained equal to twice the length of the CI pipe electrode. This is very important due to the fact that closes electrode experience an increase in their earth resistance due to mutual interference.

7.2 The location of cast iron pipe electrodes shall be planned earlier keeping in view the following:

1) The CI pipe electrode for lighting arrester and power transformer mentioned shall be as near as practicable to the respective equipment.
2) The distance between any two CI pipe electrodes should not be less than twice the length of the CI pipe electrode.
3) The lightning arrester earth connection should not be run over the ground surface.
   They should be buried at the mat depth and connected to the earth mat at the nearest point.

8.0 POWER CABLES & CONTROL CABLES:

The power cables and control cables shall be laid in a separate duct. A clearance of minimum of 0.6 mtr.shall be maintained between any earth mat conductor and the power/control cables. Parallelism of power/control cables with earth mat conductor should be avoided.

9.0 LABELING OF PIPE ELECTRODES:

The individual pipe electrodes shall be labeled for proper identification.

10.0 The transformer plinth, control room & out door switch gear shall be surrounded by MS flat of designed cross section at the

designed depth and the earth mat conductor shall be terminated on this surrounding MS flat by welding.

10.1 The earth mat shall be run below the concrete cable duct whenever the mat encounter cable ducts path.

10.2 When structures come in the way of earth mat conductor, one or two conductors may be slightly sifted. However, the designed spacing must be maintained for other earth mat conductors.

SECTION – 11: TESTING AND COMMISSIONING

Clause No.	Particulars
1.0	General
2.0	Other checks
3.0	PowerTransformers
4.0	Circuit Breakers-Pre commissioning checks
5.0	Disconnects- Pre commissioning checks
6.0	Current Transformer Pre-Commissioning Checks
7.0	Voltage Transformers - Pre-Commissioning Checks
8.0	Lightning Arrestors
9.0	Station Earthing
10.0 and	Drake / Coyote ACSR Stringing Work, Tubular Bus Work
	Power Connectors:
11.0	Aluminum Tube Welding
12.0	Insulators
13.0	Cables
14.0	Motor
15.0	Commissioning Check List for Control & Relay Panels
16.0	Commissioning Check List for Relays
17.0	Commissioning Check List for Meters
18.0	Other Equipments: Battery & Battery Charger, 415V, L.T. A.C. Panels, Diesel Generator, Distribution Transformers
19.0	Commissioning Check List for Electrical Installation General

1.0 GENERAL:

1.1 The contractor shall submit a field quality plan consisting of following:

a) Receipt, storage, pre-erection inspection of all materials in the scope of contractor

b) Structural work erection

c) Civil works

d) Welding procedure for aluminium pipe bus and earth mat system.

e) Cabling

f) Pre-commissioning tests.

g) Commissioning.

1.2 An indicative list of pre-commissioning and commissioning is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P. /instructions of the equipment supplier or owner without any extra cost to the owner. The contractor shall arrange all instruments required for -conducting these tests along with calibration certificates and shall furnish the list of instruments to the owner for approval.

2.0 GENERAL CHECKS:

2.1 Check for physical damage.

2.2 Visual examination of zinc coatings/ plating

2.3 Check from nameplate that all items are as per order/ specification

2.4 Check tightness of all bolts, clamps and connecting terminals using torque wrenches.

2.5 For oil filled equipment check for oil leakage, if any. Also check oil level and top up wherever necessary.

2.6 Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.

2.7 Check cleanliness of insulator and bushings.

2.8 All checks and tests specified by the manufacturer in the drawings and manuals as well as all tests specified

2.9 Check for surface finish of grading rings (corona control rings).

2.10 Pressure tests on all pneumatic lines at 1.5 times the rated pressure shall be conducted.

2.11 Proper lubrication of all moving parts.

2.12 Check space heaters.

3.0 POWER TRANSFORMER

3.1.0 PRE-COMMISSIONING TESTS:

3.1.1 Drying out by using streamline oil filter, vacuum pump, centrifuge and heater set.

3.1.2 Dielectric strength of oil both in main and OLTC chamber.

3.1.3 Insulation resistance of windings.

3.1.4 Checking of phase sequence test.

3.1.5 Continuity test.

3.1.6 No load voltage ratio, at all tap positions.

3.1.7 Checking of vector group, polarity and miter phase connections.

3.1.8 Tap changer operation check (Mechanical & Electrical local, remote, group and solo) including indication and alarm circuits.

3. 1. 9 Magnetizing current check at 415V, 3-Phase, 50 cycles supply for all the three phases.

3.1.10 Measurement of winding resistance.

3.1.11 Breather (check, for silica gel)

3.1.12 Buchholtz's relay operation.

3.1.13 Low oil level for main tank/OLTC chamber.

3.1.14 Physical line connections as per phasing diagram.

3.1.15 Natural connection to earth effectivity.

3.1.15.1 Calibration of different temperature indicators, relays, switches.

3.1.16 Cooler control operational check both from local and remote.

3.1.17 Check all fans and oil pumps.

3.1.18 COMMISSIONING:

After obtaining approval from the purchaser and supplier the contractor shall proceed to commission the transformer.

3.2.0 GENERAL CHECKS TO BE DONE BEFOPE/AFTER COMMISSIONING

3.2.1 All off valves are in correct positions, closed or opened as required.

3.2.2 All air pockets are filled with oil.

3.2.3 Thermometer pockets are filled with oil.

3.2.4 Oil is at correct levels in the bushings, conservator, diverter switch tank, etc.

3.2.5 Earthing connects are done.

3.2.6 The condition of silica gel in the breathers.

3.2.7 Arcing horn gaps on bushings are properly adjusted.

3.2.8 Heaters in cubicles, conservator etc., where provided should be checked.

3.2.9 Any other alarm / trip contacts of flow meters differential pressure gauges etc.

3.3.0 If all the above tests/checks are found satisfactory, a time of at least 24 hours for setting of oil shall be allowed and air released from all points. The transformer shall be energized after setting the protective relays to the minimum extent possible. Wherever possible the voltage shall be built up in steps. Any abnormality during commissioning such as vibration of radiator parts, hum etc., should be observed. After a few hours of energization at no load, the transformer shall be switched off. The Buchholz relay should be checked for collection of air/ gas. Abnormalities noticed shall be corrected. All protective relays should be reset to normal values. Transformer shall be re-energized and loaded gradually.

3.3.1 After commissioning the contractor shall furnish the test results and all relevant details, drawings of erection testing and commissioning of the Purchaser all properly bound With plastic jackets.

4.0 CIRCUIT BREAKER - PRE-COMMISSIONING CHECKS:

4.1 Insulation resistance of each pole.

4.2 Check adjustments, if any, suggested by manufacturer.

4.3 Breaker closing and tripping time, pole discrepancy etc.

4.4 Slow and power closing operation and opening.

4.5 Minimum pick up voltages of trip and close coils.

4.6 Contact resistance.

4.7 Functional checking of compressed air plant and all accessories including adequacy of the air receiving for design set of operations.

4.8 Functional checking of control circuits, interlocks, tripping through protective relays and re-close operation.

4.9 Insulation resistances of control circuits, motor, etc.

4.10 Resisting of closing and tripping coils.

4.11 Check on simultaneous closing of all three poles, three- phase/single phase auto re-closures.

4.12 Blocking of operation at low pressure.

4.13 Checking of electrical & mechanical interlocks.

5.0 DISCONNSECTS - PRE-COMMISSIONING CHECKS:

5.1 Insulation resistance of each pole.

5.2 Manual and electrical operation and interlocks.

5.3 Insulation resistance of control circuits and motors.

5.4 Ground connections of structures & operating handle.

5.5 Contact resistance of each pole per gap between male and female contacts.

5.6 Proper alignment so as to minimise to the extend possible the vibration during operation.

5.7 Measurement of operating Torque for Isolator and Earth switch.

5.8 Resistance of operating and interlocking coils.

5.9 Manual and Electrical interlocks.

5.10 Clearances in open & closed operations.

6.0 CURRENT TRANSFORMER - PRE-COMMISSIONING CHECKS:

6.1 Insulating Resistance test.

6.2 Polarity test.

6.3 Ratio identification test - checking of all ratios on all cores by primary injection of current.

6.4 Dielectric test of oil (wherever applicable).

6.5 Magnetizing characteristics test.

6.6 Checking of earth connection at only one point.

6.7 Shorting of spare C.T. cores.

6.8 Dielectric tests (wherever applicable).

6.9 Checking gas pressure wherever required.

7.0 VOLTAGE TRANSFORMERS - PRE-COMMISSIONING CHECKS

7.1 Insulation Resistance Test

7.2 Polarity test of all windings

7.3 Patio test of all windings

7.4 Dielectric test of oil (wherever applicable)

7.5 Open delta test with low voltage (wherever applicable)

7.6 Capacitance and tan delta measurement.

7.7 Checking gas pressure measurement where required.

8.0 LIGHTNING ARRESTOR.

8.1 Grading leakage current

8.2 Resistance of ground connection.

9.0 STATION EARTHING:

9-1 Check soil resistivity

9.2 Check continuity of grid wires

9.13 Check earth resistance of the entire grid as well as various sections of the same.

9.4 Check for weld joint and application of zinc rich paint on galvanised surfaces.

9.5 Dip test on earth conductor prior to use.

10.0 DRAKE / COYOTE ACSR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS:

10.1 Physical check for finish

10.2 Electrical clearance check

10.3 Testing of torque wrenches on all bus bar power connectors and other accessories.

10.4 Millivolt drop test on all power connectors.

10. 0 Sag and tension check on conductors.

11.0 ALUMINIUM TUBE WELDING:

11.1 Physical check

11.2 Millivolt drop test on all joints.

11.3 Die penetration test/Radiography test on 10% sample basis on weld joints.

11.4 Test check on 5% sample Joints after cutting the weld piece to observe any voids, etc.

12.0 INSULATORS:

12.1 Visual examination for finish, damage, creepage distance etc.

13.0 CABLES:

13.1.0 PRELIMINARY CHECKS:

13.1.1 Check details as per specification.

13.1.2 Check for physical damage.

13.2.0 COMMISSIONING CHECKS:

13.2.1 Megger test between each core &armour/sheath.

13.2.2 Continuity check.

13.2.3 Connections.

13.2.4 And all other checks as specified by equipment manufacturers/ Engineer.

14.0 MOTOR

14.1.0 PRELIMINARY CHECKS:

14.1.1 Check name plate details according to specification.

14.1.2 Check tightness of all bolts, clamps and connecting terminals.

14.1.3 Check ground connections.

14.1.4 Bearing lubrication.

14.1.5 Check clearance inside terminal box.

14.2.0 COMMISSIONING CHECKS:

14.2.1 Megger testing of motor windings and cables.

14.2.2 Motor Windings, control and power cables continuity check.

14.2.3 Resistance of motor windings in case of large motors.

14.2.4 Control and interlocks.

14.2.5 Overload and short circuit relay tests and settings.

14.2.6 Phase sequence and rotation.

14.2.7 Operating of timer in case of star-delta starting.

14.2.8 Starting and no-load current.

14.2.9 No. of load operation (observe vibrations, temperatures of bearings and body of the motor)

14.2.10 On load operation, starting and running currents (observe vibrations, temperatures of bearings and body).

14.2.11 In case of close loop arrangement for cooling the windings of the motor, inlet and outlet temperature of the cooling air.

14.2.12 And all other checks as specified by equipment manufacturers/ Engineer.

15.0 COMMISSIONING CHECK LIST FOR CONTROL & RELAY PANELS:

15.1.0 PRELIMINARY CHECKS:

15.1.1 Check name plate details of every associated equipment according to specification

15.1.2 Check for physical. damage of various meter and relays.

15.1.3 Check tightness of all bolts and nuts and wiring terminals.

15.1.4 Check earthing

15.2.0 COMMISSIONING CHECKS:

15.2.1 Switch developments.

15.2.2 Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawings. All inter connections between panels/ equipment shall be similarly checked.

15.2.3 All the wining shall be meggered.

15.2.4 Checks on relays.

15.2.5 Checks on meters.

15.2.6 Settings of relays, other alarm, tripping device, and interlocks as per schemes.

15.2.7 Phase angle checks - Measurement of magnitude and phase angle of current transformer secondary currents and potential transformer secondary voltages.

15.2.8 Functional checking of all control circuitry - viz., closing, tripping, control, interlock, supervision and alarm circuits including proper functioning of the component equipment.

16.0 COMMISSIONING CHECK LIST FOR RELAYS:

16. Check name plate details according to specifications.

16.2 Check for any physical damage.

16.3 Check internal wiring

16.4 MEGGER:
- a) All terminals to body.
- b) A.C. to D.C. terminals.

16.5 Check operating characteristics by secondary injection.

16.6 Check minimum pick-up voltage of D.C. coils.

16.7 Check operation of electrical mechanical targets.

16.8 Relay settings.

16.9 Check C.T. and V.T. connections, with particular reference to their polarities for directional distance type relays.

17.0 COMMISSIONING CHECK LIST FOR METERS:

17.1 Check name plate details according to specifications.

17.2 Check for physical damage.

17.3 Check calibration by comparing with substandard.

17.4 Megger all insulated portions.

17.5 Check C.T. and V.T. connections with particular reference to their polarities for Power type meters.

18.0 OTHER EQUIPMENTS : BATTERY & BATTERY CHARGER, 415V, L.T. A.C. PANELS, DIESEL GENERATOR, DISTRIBUTION TRANSFORMERS:

18.1 The pre-commissioning/commissioning checks and tests shall be carried out in accordance with the manufacturer's instruction manual and instructions of the owner. The charge /discharge cycle of battery shall be strictly followed.

19.0 COMMISSIONING CHECK LIST FOR ELECTRICAL INSTALLATION GENERAL:

19.1.0 Phasing out.

19.1.1 By means of phasing rods, if available or by measuring voltages on voltages transformer secondary.

19.2.0 FUNCTIONAL CHECKING:

19.2.1 Checking all closing, tripping, supervision and interlock of control devices.

19.2.2 Check operation of all alarm circuits.

19.3.0 CABLE TESTING:

19.3.1 All 11KV, 415V and 230V power cables are to meggered with suitable meggers to check the insulation resistance.

19.4.0 EARTHING:

19.4.1 Measure resistance of each earth well/rod by isolating the same from station grid as well as from other earth wells/rods and then measure resistance of two earths at a time by D.C. drop method.

19.4.2 Check continuity of grid conductor and wires.

19.4.3 Soil resistivity tests.

19.5.0 In addition to the above, any other tests specified by manufacturers shall be carried out as the manufacturer's instructions.

19.6.0 Test fire detection system if provided.
Check operation of protective relays by putting short circuit bar at different location, conduct system stability test by primary injection test method.